"Few Know an Earl in Fishing-clothes"

Fish Middens and the Economy of the Viking Age and Late Norse Earldoms of Orkney and Caithness, Northern Scotland

Volume I

James Harold Barrett

Ph.D.

University of Glasgow

Department of Archaeology

December 1995

Abstract

This thesis studies the origin and role of wealth in the Viking Age (late 8th to 11th century) and Late Norse (11th to 15th century) earldoms of Orkney and Caithness, northern Scotland. It has four aims. Firstly, it attempts to elucidate the key sources of wealth in the earldoms and, more specifically, the possible economic role of fish trade. Secondly, it investigates how control of these sources of wealth may have been distributed within Viking Age and Late Norse society. Thirdly, it attempts to isolate chronological trends in the utilisation of different sources of wealth and the social relations surrounding them. Finally, it was hypothesised that a consideration of these issues might illuminate the character and causes of the transition of Orkney, Caithness and Shetland from a semi-independent and non-Christian Viking Age polity to a periphery of medieval Christian Europe.

Part 1 is a geographical and protohistorical survey of Viking Age and Late Norse Orkney, Caithness and Shetland. It discusses available evidence and establishes the considerable wealth of the earldoms. Part 2 investigates the possible *sources* of this wealth. It concludes by highlighting circumstantial evidence for an export trade in cured fish. Zooarchaeological and archaeobotanical data receive particular attention. New methodological tools for interpreting the weight of zooarchaeological assemblages are also discussed. In Part 3, the possibility that medieval fish middens (at sites such as Robert's Haven, Caithness) represent waste from the production of cured fish for export is considered in detail. It is argued that the scale of these deposits is consistent with commercial fishing. Moreover, detailed study of butchery practices suggests that cured fish products known to have been traded from Northwestern Europe were probably made at Robert's Haven.

The thesis facilitates several conclusions. Long range market exchange was probably of socioeconomic importance in both the Viking Age and the Late Norse Period. However, *available* historical and archaeological evidence can demonstrate the export of cured fish from the earldoms only by the 13th-14th centuries. This trade may have been of particular importance to magnates and *bœndr* (free 'farmers') whose agricultural produce was extracted by earls and the church as tax and tithe. By facilitating the acquisition of exotic material culture, an export trade in cured fish may have provided a mechanism by which independent 'farmers' could emulate and perhaps even challenge the status of their putative superiors. Uncertainty regarding dating makes it impossible to suggest whether fish trade was related to the 11th century transformation of Orkney, Caithness and Shetland to a periphery of medieval Europe. Future research, intended to identify and date further fish middens in northern Scotland, may help resolve this issue.

Acknowledgments

Many individuals and organisations have made this thesis possible. First of all, I would like to thank my supervisors, Christopher Morris and Paul Buckland, for their constant guidance and encouragement. Special thanks are also owed to Colleen Batey, Rachel Harry, Ingrid Mainland and James Rackham for answering my ceaseless questions and providing unpublished data regarding excavations at Earl's Bu, Beachview and Freswick Links.

Excavation and postexcavation components of the Robert's Haven project could never have happened without the kind cooperation of the landowners - shareholders of the Duncansby Head Common Grazings. A particular debt of gratitude is owed to Magnus Houston, William Steven and their families. The project was generously funded by the Caithness District Council, the Glasgow Archaeological Society, the Hunter Archaeological Trust, the Society for Medieval Archaeology, the Rosemary Cramp Fund, the Society of Antiquaries of Scotland and the University of Glasgow. Historic Scotland provided radiocarbon dates and helpful advice through the kind auspices of Patrick Ashmore and Olwyn Owen.

I am also deeply indebted to the many researchers who have taken responsibility for specialist aspects of the Robert's Haven project: Paul Buckland (insects), Lorna Campbell (conservation), Andrew Dugmore (tephra), Jacqui Huntley (botanical macrofossils), Paul Johnson (geophysical survey), Andy Jones (fibre tempered pottery), Sarah King (drafting), Euan MacKie (querns), Ingrid Mainland (mammal bone), Lorraine McEwan (drafting), Terry O'Connor (terrestrial molluscs), Julie Ross (fibre tempered pottery), Ian Simpson (soil micromorphology), Tanya O'Sullivan (bird bone), Susan White (botanical macrofossils), Judith Turner (terrestrial molluscs) and Bob Will (wheel made pottery). Fieldwork was conducted with the invaluable assistance of volunteers who endured long hours and inclement weather with remarkably good humour. Particular thanks are owed to Kevin Brady, Rachel Harry, Heather Henderson, Rob James, Sarah King, Sinclair Manson, Sally Hill, Julie Ross and George Watson. Local school students also made a welcome addition to the field crews. Postexcavation sorting of sediment samples was carried out with the assistance of student volunteers from the Department of Archaeology, University of Glasgow. Stuart Jeffrey acted as my laboratory assistant during much of this work. His skilled and patient help has been priceless.

Several people have provided assistance with the translation of articles or primary sources in Latin, German, Polish, Norwegian, Old Norse and Spanish. I would like to thank Ruby Cerón-Carrasco, Barbara Crawford, Danna Gabry, Dirk Heinrich, Adam McNaughton, Sigrid Morrison, Ross Sampson, Brian Smith and Eila Williamson for their kind help.

I am also deeply indebted to everyone who has shared their thoughts and research results with me in the form of conversations, offprints and unpublished reports. In addition to those named already, special thanks are due to: Colin Adams, Umberto Albarella, Anne Allen, Thomas Amorosi, Peter Anderson, Colin Andrew, Ted Banning, Michael Barnes, László Bartosiewicz, Reidar Bertelsen, Gerald Bigelow, Julie Bond, Dick Brinkhuizen, Anne Brundle, Stephen Carter, Camilla Dickson, Keith Dobney, Steve Driscoll, Klaus Friedland, Sheila Hamilton-Dyer, Steffen Stummann Hansen, John Hunter, Brian Irving, Andrew Jones, Sigrid Kaland, Raymond Lamb, Daphne Lorimer, Christopher Lowe, Thomas McGovern, Alex Morrison, Rebecca Nicholson, Sebastian Payne, Sophia Perdikaris, Elizabeth Reitz, Dale Serjeantson, Niall Sharples, Andrea Smith, Catherine Smith, Przemyslaw Urbanczyk, Maria Vretemark, Birgitta Wallace, Doreen Waugh, Barbara West, Gareth Williams and Cynthia Zutter. Patrick Connor produced a cornucopia of relevant references and Nancy Houston brought my attention to Matheson's (1817) map of Duncansby. Furthermore, John Barrett, Ewan Campbell, Edward Cowan, Sarah King, Suzanne Needs-Howarth, Terry O'Connor, Olwyn Owen, Sebastian Payne and Trevor Ringrose read early versions of portions of this work. Their insightful comments and criticisms have been instrumental in shaping its final form.

Harry Kenward and Keith Dobney kindly arranged access to laboratory facilities and reference material at the Environmental Archaeology Unit, University of York. Access to reference specimens was also generously provided by Darlene Balkwill and Kathlyn Stewart of Zooarchaeology, Canadian Museum of Nature, and by Sebastian Payne and Simon Davis of the Ancient Monuments Laboratory, English Heritage. Fish reference specimens were donated by the Department of Agriculture and Fisheries for Scotland Marine Laboratory, Aberdeen. Dirk Heinrich assisted me with the identification of several troublesome otoliths. I would also like to thank Peter Ainsworth who conducted elemental analysis of a copper alloy spoon from Robert's Haven.

James Currall and Tom Aitchison offered helpful statistical advice regarding regression analysis. Trevor Ringrose provided the programme and advice which made the correspondence analyses of Chapter 7 possible. I owe him particular thanks for making my visit to Aberdeen comfortable and memorable. I doubt, however, that I will ever play football again!

Section 5.2.4 of the thesis, including associated figures and tables, was previously published by the author (Barrett 1994). Figures 5.5, 5.7, 5.8 and 7.41 were drawn by Lorraine McEwan. References regarding figures derived from other publications are given in the captions. The sources of plates are also provided in captions. However, particular thanks are due to the Archiv der Hansestadt Lübeck, the British Library, the Orkney Library and the University of Glasgow Library for permission to reproduce images. I offer my gratitude for the help of Antjekathrin Graßmann and David Mackie in this regard. The woodcut figures used at the beginning of each section of the thesis are from Olaus Magnus' *Carta Marina* (on page 20, reproduced from Lynam 1936) and *Historia de Gentibus Septentrionalibus* (on pages 79 and 192, from Magnus 1555:699, 732 by kind permission of the University of Glasgow Library). The Royal Commission on the Ancient and Historical Monuments of Scotland was extremely helpful with the provision of both aerial photographs and archaeological site records.

This research was conducted with the constant intellectual feedback, technical assistance and moral support of my wife, Sarah King. I would also like to thank David and Mary Barrett for their support during ten years of university education.

The project has been supported by funding from the Commonwealth Scholarship Commission in the United Kingdom, the Social Sciences and Humanities Research Council of Canada and the Professor D. O. Robson Graduate Scholarship of Victoria College, University of Toronto.

Table of Contents

Part 2
Sources of Wealth

List of Figures

List of Tables

List of Plates

List of Appendices

Chapter 1
Introduction

1.1 The Research Question

This thesis attempts to elucidate the sources of wealth in the Viking Age (late 8th to 11th century) and Late Norse (11th to 15th century) earldoms of Orkney and Caithness, northern Scotland. More specifically, it investigates the possibility that the earldoms were engaged in a pan-European cured fish trade which influenced the fortunes and misfortunes of better documented Scandinavian polities in Norway and Iceland (Amorosi 1991:280-281; Bertelsen 1991:25-26; Bertelsen 1992; Gelsinger 1981:181-194; Buckland et al. 1994; Urbanczyk 1992:228-261).

Dried cod family (Gadidae) fishes, demanded in Britain and continental Europe for purposes as diverse as Lenten fare and military rations (Hagen 1993:130; Hammond 1993:63; Heinrich 1986; Prestwich 1967), were probably exported from Arctic Norway by the 11th century (Bertelsen 1992:179). Iceland followed a similar trend two centuries later (Gelsinger 1981:181). Fish trade contributed to the incorporation of these 'peripheries' of the medieval world into the milieu of contemporary European Christian culture (Bertelsen 1991:25-26; Bertelsen 1992; Gelsinger 1981:181-194; Buckland et al. 1994; Urbanczyk 1992:230-239).

During the Viking Age and Late Norse Period much of Northern Scotland - including Caithness and the archipelagos Orkney and Shetland - was ruled by the earls of Orkney as a semi-independent Scandinavian colony (see Chapter 4). Was this polity also incorporated into medieval Europe by participation in the trade of cured fish? Furthermore, can the wealth of Norse Orkney, Caithness and Shetland - expressed through silver hoards, monumental architecture and hierarchical social relations - be attributed at least in part to such an activity?

Historical evidence regarding Orkney, Caithness and Shetland is relatively tenuous prior to the 16th century (see Crawford 1982; 1985b; MacGregor 1984; Thomson 1987). Nevertheless, distinctive 'fish middens' dominated by bone from cod and related species have been discovered at the Late Norse sites Robert's Haven (Barrett 1992c; Morris et al. 1994) and Freswick Links (Batey 1989b; Jones 1991a; Jones 1991b; Jones et al. 1983; forthcoming b; Morris et al. 1992:97; Rackham et al. 1984) in Caithness. They may also exist at Quoygrew, Orkney (Colley 1983a:208-217; Colley 1984), St. Boniface, Orkney (Cerón-Carrasco 1994; Cerón-Carrasco forthcoming), and Sandwick, Shetland (Bigelow 1984:125-135; Bigelow 1985:121;

Bigelow 1989:188-191; Bigelow 1992:19-20) (see Section 7.2). Fish bones are also abundant, although perhaps less dramatically so, at a number of other Late Norse and Viking Age settlements. The most important of these are: Tuquoy, Pool, Brough Road Areas 1 and 2, Beachview Burnside Area 2, Beachview Studio Site and Saevar Howe (see Table 5.1 for references and Figure 1.2 for site locations). Could some of these deposits represent the residue from cured fish processing for export?

This question can be addressed by combining zooarchaeological data, limited direct historical evidence, and appropriate analogies from other regions of the North Atlantic or later periods in the history of northern Scotland. On the basis of this work it may be possible to elucidate the key sources of wealth in the earldoms, and more specifically, the potential economic role of a putative fish trade. It is also hoped to shed light on two associated socioeconomic issues. Firstly, how were the sources of wealth, and wealth itself, distributed and controlled within Viking Age and Late Norse society? Secondly, did the sources of wealth, and social relations surrounding them, change over time? A discussion of these issues may illuminate the character and causes of the transition of Orkney and Caithness from a semi-independent and non-Christian Viking Age polity to a periphery of medieval Christian Europe.

1.2 The Study Boundaries

The geographical boundaries of the study change through time. During much of the Viking Age and the early centuries of the Late Norse Period the authority of Orcadian earls may have stretched from Shetland in the north to at least the River Oykel on the Scottish mainland (Crawford 1987:57; see Figure 1.1). This substantial area, extending c.400km from north to south, forms the central focus of the current study. It is likely, however, that the influence of the earls also extended further south and west into the Hebrides and Man, for short periods of time (e.g. Dolley 1981:175).

This area of influence, and the virtual independence of the colony, began to shrink in the Late Norse Period. Evidence that Caithness, the mainland portion of the colony, was perceived as a separate earldom by the 11th century foreshadows the change (e.g. Pálsson & Edwards 1981:38). From this time, Caithness was theoretically held by the Orcadian earls at the behest of Scottish, as opposed to Norwegian, kings (Crawford 1985b:25). These claims of Scottish sovereignty were initially of little significance. The two earldoms were held as a single polity by the earls of Orkney (Crawford 1985b). In the early 13th century, however, the southern portion of Caithness was erected as a separate earldom, Sutherland, by the King of Scotland (Crawford 1985b:32-33). Later, in 1375, the remainder of Caithness was also surrendered to the Scottish crown (Crawford 1982:72).

In the north, Norwegian royal power was expanding. Shetland was confiscated from the earls of Orkney in 1195 and administered by royal officials thereafter (Sephton 1899:156-157; Crawford 1985a:129). The archipelago is largely outwith the bounds of the current study after this date. Nevertheless, it is unhelpful to omit the later history and archaeology of Shetland completely. Archaeological sites cannot be precisely dated to before or after 1195 and economic evidence from 13th-15th century Shetland may cast light on more southerly practices.

Orkney remained a Norwegian colony until 1468 (Donaldson 1974:85-87), the date sometimes used to terminate the Late Norse Period (e.g. Morris 1985:210). However, the present study concludes earlier in the 15th century. In (or shortly before) 1416 the Hanseatic League began direct trade with the Northern Isles, particularly for cured fish (Friedland 1983:88; see MacAskill 1982:409-411 for corroborating archaeological evidence, postmedieval continental pottery, from Kirkwall). Direct contact with the Hansa opens another chapter in the history of the islands, one in which the significance of fish trade is not in doubt. While the 15th and later centuries provide useful analogies for possible earlier events (see Section 3.3), it is the relatively unknown previous years which this study hopes to illuminate.

Although precise historical dates have been used in the discussion so far, a broader chronological perspective is essential to facilitate the interpretation of archaeological data. The Viking Age (c.9th -11th centuries) and Late Norse Period (c.11th - 15th centuries) have already been introduced. Although the dates attributed to these periods vary slightly (e.g. Batey 1991a:29; Bigelow 1985:104; 1987:24; Owen 1993:321, 329), and at least one scholar has chosen not to use them at all (Hunter 1986:71-72), they have gained relatively widespread currency. It is worth noting that this scheme approximately parallels Norwegian terminology. In the latter, however, the period after 1050 is understandably described as the Middle Ages rather than the Late Norse Period (*Nordic Archaeological Abstracts* 1990:281).

The "Middle Ages" (and the associated adjective, "medieval") are sometimes used in Scottish Norse studies. They occur as synonyms for the Late Norse Period (e.g. Crawford 1985a:130-131; Lamb 1980a:90; Thomson 1993:340) or as labels for the last two or three centuries of Norse political control (e.g. Morris & Emery 1986:357; Owen 1993:321, 329). In this study, the "Middle Ages" is used (in its Scandinavian sense) as a synonym for the Late Norse Period. However, the latter *is* divided into Late Norse 1 (LN1, 11th - 13th centuries) and Late Norse 2 (LN2, 13th - 15th centuries) to recognize that different political and socioeconomic features are likely to characterize the centuries before and after the waxing of Scottish and Norwegian royal power in the

North. The decimation of the Norse Orcadian elite in a shipwreck of 1232 is perhaps a useful turning point (Crawford 1985b:34; Dasent 1894b:158; see Chapter 4).

The Viking Age is similarly divided for the purposes of this study. Recent scholarship has illustrated the usefulness of a distinction between an initial contact and colonisation phase - in the 9th (and possibly late 8th) centuries - and a later (late 9th or 10th century) consolidation of a formal earldom (e.g. Hunter et al. 1993:273, 280-281; Morris 1991:78-80). The former is referred to as Viking Age 1 (VA1, late 8th - late 9th centuries), the latter as Viking Age 2 (VA2, late 9th to 11th centuries). The justification for this division is further illuminated in Chapter 4.

The chronological terminology of the Norse earldoms can thus be summarised as follows:

	Suggested Terminology		**Broad Chronology (centuries)**	**Historical Boundary Dates**
Viking Age	Viking Age 1	VA1	8th - late 9th	
	Viking Age 2	VA2	late 9th - 11th	
Late Norse ('Medieval')	Late Norse 1	LN1	11th - 13th	ends in 1232
	Late Norse 2	LN2	13th - 15th	1232-1416

1.3 Previous Research: Inspiration and a sea of troubles

1.3.1 Studies of Viking Age and Late Norse Economy

Past assessments of the role of wealth in Viking Age and Late Norse Orkney, Caithness and Shetland have considered a single source of evidence, a single chronological period or a narrow geographical region. Studies of Viking Age silver and gold by Graham-Campbell (1976; 1985; 1993; 1995), Warner (1976) and Kruse (1993) address the use of currency and prestige objects, but do not consider the relationship between bullion or coins and primary economic activities such as fishing and agriculture. Kaland's (1982) study *Some economic aspects of the Orkneys in the*

Viking Period takes a more holistic approach. She addresses both exchange and subsistence activities, but considers only a portion of the earldoms during the Viking Age. Bigelow's (1984; 1985; 1989) economic analyses of Late Norse Shetland provide an important starting point for the present study (see below). However, they too focus on one region of the Norse colony during a relatively narrow chronological range. A survey of economic patterns around Birsay Bay in the Viking Age and Late Norse Period (Morris & Rackham 1989) takes a broader chronological perspective, but sets itself more stringent geographical limits. Other more synthetic studies (e.g. Crawford 1987:149-154; Morris 1985:232-234; Wilson 1976:110-111) or discussions of artifacts, faunal remains and botanical macrofossils from specific archaeological sites (see Appendices 3.1-3.3 for site report references) have touched only briefly on socioeconomic issues.

In contrast to the paucity of holistic palaeoeconomic studies, the role of fishing in the economy of Orkney, Caithness, Shetland and other west Norse colonies has received considerable attention. Its importance has been assumed for decades in both specialist reports (e.g. Hamilton 1956:6) and synthetic historical surveys (e.g. G. Jones 1984:155; Smyth 1984:148; Wainwright 1962b:117). Moreover, a number of primary studies by archaeologists, zooarchaeologists and a historical geographer provide a substantial background for the current project (Batey 1989b; Bigelow 1984; Bigelow 1985; Bigelow 1987; Bigelow 1989; Colley 1983a; Colley 1983b; Colley 1983c; Colley 1984; Colley 1986; Colley 1988; Colley 1989; Colley 1990:227-228; Donaldson et al. 1981; Goodlad 1971; Hamilton 1956; Jones et al. 1983; Jones 1991a; Jones 1991b; Kaland 1982:91; Morris et al. forthcoming a; Morris et al. 1992; Morris & Rackham 1989; Nicholson n.d.a; Nicholson n.d.b; Rackham et al. forthcoming d; Wheeler 1976-1977).

1.3.2 Fishing in Late Norse Shetland: The work of Hamilton, Goodlad and Bigelow

J. Hamilton (1956) established fishery studies in Scandinavian Scotland by raising the possibility that fishing intensified during the Late Norse Period in his report on excavations at Jarlshof, Shetland. Possible line sinkers were rare in Viking levels of Jarlshof, but very common in Late Norse phases (Hamilton 1956:6). As argued below, however, this may measure the intensity of local steatite working rather than the intensity of fishing.

Hamilton's argument has been built upon by Alistair Goodlad and particularly by Gerald Bigelow. Goodlad suggested that fishing for export dated to the Norse (i.e. Viking Age *and* Late Norse) period in Shetland, but relied largely on analogies from other regions of Scandinavia and later periods in Shetland's history (1971:48-63). In conclusion he suggested that "substantiation of processing and trade in fish is ... difficult although it is unlikely that such potential export goods were overlooked" (Goodlad 1971:63).

The antiquity of commercial fishing has been a focus of particular attention in Bigelow's studies of Late Norse Shetlandic economy. He suggested that fish substituted for pastoral products such as butter extracted from peasants as tax and tithe (Bigelow 1984:216-230; 1989:189-190). First, he argued that large numbers of small saith represented at Sandwick were used for domestic consumption (based on their traditional role in Shetland, historical records that they were not in commercial demand, and the ease with which they can be caught) (Bigelow 1984:199; 1985:121, 123). Second, Bigelow proposed that large bones from gadoid fish recovered at Sandwick derived from fish destined for the historically documented medieval stockfish trade centred at Bergen (1984:128-129, 216-217; 1985:121-124; 1989:189-190). He postulated that this exchange provided cereal products to offset a possible nutritional deficit created by tributary demands (Bigelow 1984:223-228). The five bases of his conclusion included:

1) an increasing number and proportion of fish bones in the Sandwick middens through time
2) increasing numbers of line sinkers of diverse types,
3) increasing numbers of imported artifacts,
4) the historically documented Norwegian stockfish trade and
5) the under-representation of vertebrae in one late context at Sandwick, a pattern Bigelow equated with the export of these elements with processed fish (Bigelow 1984:126-129, 184-230; 1989:187-191).

By considering several lines of evidence, Bigelow was able to construct a thorough and plausible model. Nevertheless, the bases of his argument are not all strong. As at Jarlshof, the increase in sinker deposition is likely a measure of domestic steatite working, not of intensified fishing. Many sinkers were discarded unfinished (Bigelow 1985:119) and similar artifacts are not ubiquitous finds in Orkney and Caithness where faunal evidence also demonstrates large scale fishing (e.g. Batey 1987a:152-155;1989a; Batey et al. forthcoming a; Batey & Morris 1983; Curle 1982; Hunter 1986:181-207; Ritchie 1976-1977:192-201). Bigelow's suggestion that the quantity of imported products increased in the 12th century is also problematic. Imported currency, antler combs, wood and probably other products demonstrate the existence of substantial trade contacts in the 11th century and earlier (see Section 6.10). For the purposes of the current study the most significant limitation of Bigelow's work is its exclusive focus on Shetland. Concurrent developments in Orkney (part of the same earldom until 1195) and Caithness (ruled by the earls of Orkney until 1375) are not considered.

1.3.3 Early Research in Orkney: The work of Wheeler, Donaldson et al. and Colley

Norse fishing has not gone unstudied in Orkney and Caithness. Alwyne Wheeler (1976-1977), in his analysis of fish bones from Pictish and subsequent Viking layers of Buckquoy, suggested that a shift from shore to deep-sea fishing characterised this chronological and cultural transition. Large individuals of species such as cod, ling, gurnard and saith or pollack, which do not tend to occupy shallow waters today, were present predominantly in Viking phases (Wheeler 1976-1977:212-214). Although Wheeler described only a small assemblage from a single site, he raised one of the questions which has since dominated fish bone studies in Orkney and Caithness; was the fishery intensified over time, and if so, in what period?

A.M. Donaldson and her co-authors (Donaldson et al. 1981) contributed to this issue, suggesting that fish became a significant resource not "with the onset of Norse occupation, but rather with later phases of the recognized occupation [at Buckquoy and in Room 5 on the Brough of Birsay]" (Donaldson et al., 1981:77). Sarah Colley (1990:227-228) criticised their conclusion, based as it was on two small samples, but raised a similar possibility herself (Colley 1989:259). She suggested that commercial fishing developed in the Viking Age and Late Norse Period (Colley 1983a:171, 382-383; 1983b:169; 1984:127; 1989:258-259). Using the present ecological distribution of fish taxa, her argument was built on the inference that large cod, ling and other species (represented in faunal assemblages from Viking Age sites such as Saevar Howe and Brough Road Areas 1 and 2 [Colley 1983b:169; 1983c; 1989] and Late Norse sites such as Quoygrew, Tuquoy and Beachview [Colley 1983a:208-217, 229-234; 1988; 1989:259; Rackham et al. forthcoming d]) were caught by an offshore fishery. In her estimation, this would have demanded an investment of equipment and particularly risk inconsistent with fishing for local subsistence needs (Colley, 1983a:382-383; 1983b:169). As she concluded (regarding the Viking Age Brough Road sites in this case):

> It is tempting to argue that the deep water fishery for larger cod, ling, saith, hake and torsk, the bones of which dominate the archaeological samples, may have been aimed at surplus production for exchange, in addition to providing food for the fishermen (Colley 1989:258).

This interpretation, originally formed in the mold of risk minimization models (Colley 1983a:75-97), is not without problems (see Nicholson, n.d.b:29-30). While modern ecological data are tempting fodder for zooarchaeological mastication, their legitimacy is questionable in this particular byre. As Wheeler (1978b:74) explains, sizes and taxa of fish which are currently found only in offshore waters might have occupied shallower ranges prior to modern fishing pressure. With this in mind it is relevant to note several eighteenth century comments regarding the location of fishing grounds in the Northern Isles:

> The Fishing here is much decayed by what it was, for now neither is there such a great number of Fishes taken, nor so easily can they be had, as formerly; *for not above 40. or 50. Years since, the Fishers would have taken the great Fishes, such as Killen [cod], Ling &c. in the Voes or Lochs, and that in great numbers, and so were not necessitated to underly such danger and toil, in going out to the Sea*, but could have lien before their oun doors, and drawen the Fishes, which certainly was more safe, easy, and convenient to them in many Respects: Whereas now they are obliged to put out some Leagues unto the Sea, and so far often that they almost sink the Land, else they cannot have any Fishing, worth their expence and pains (Brand 1883[1701]:193-194 emphasis mine).

> [I] Observed foundations of a great number of huts, placed in regular order, said to be these of the fishermen, *when the larger kinds of fish were to be found nearer the land* (Low 1879 [1774]:85 emphasis mine).

These accounts may be romantic manifestations of a fictitious golden age, but they could record a real change in fish distributions. It is equally interesting that the adoption of the sixareen in 18th century Shetland (over a smaller boat, the yole) has been attributed to the introduction of offshore 'haaf' fishing (Henderson 1978:55).

Even if the presence of large cod and ling is indicative of offshore fishing, it is difficult to justify the assumption that this can be equated with a commercial exercise. Similar taxa and sizes of fish have been found in much earlier prehistoric contexts, at the Mesolithic site of Morton, Fife, Scotland, for example (Coles 1971:351-353). Following Colley's logic it would be necessary to postulate the unlikely prospect of an export fish trade in the Mesolithic.

In addition to her first argument, Colley has also suggested that skeletal element frequency data from Tuquoy and Quoygrew could imply the removal of appendicular elements (such as cleithra, supracleithra and posttemporals) and vertebrae with exported gadoid fish (Colley 1984:127; 1989:255). She envisioned a product in which the head was removed anterior to bones of the appendicular skeleton such as the cleithrum, leaving most or all other elements in the exported product (Colley 1984:127; 1986:35; see Figures 1.3 and 1.4).

Element frequency data are important resources which have been used in a variety of contexts to identify and interpret fish processing (e.g. Butler 1993; Stewart & Gifford-Gonzalez 1994; Van Neer & Muniz 1992; Wilkinson 1979). Alone they cannot indicate the export of cured fish; fish may be processed at one location and used at another, even for domestic consumption. Nevertheless, they may provide two important pieces of information:

1) whether an archaeological site (or feature) derived from processing or consumption and
2) whether the processing technique conformed to patterns described in early records of the northwest European cured fish trade.

In brief, element frequency data may open or close the *possibility* of cured fish export.

Colley (1984:127; 1989:255) suggested that appendicular elements and vertebrae were under-represented specifically in reference to the Late Norse sites Tuquoy and Quoygrew. She has also mentioned two other Orcadian sites, Cleat and Evertaft, but these are undated and need not concern us here (Colley, 1983a:217-228; 1984:127). Table 1.1 includes an abbreviated list of the original fragment count data for all Gadidae taxa combined (from Colley, 1983a:341-342; note that complete data are only available for Tuquoy material excavated in 1982). Figure 1.4 displays these data, standardized for comparative purposes by dividing each element by the number in a single fish. A range is given for vertebrae because the number per fish can vary from a minimum of 49 in cod to a maximum of 67 in torsk (Whitehead et al. 1986a:686-703). Given the dominance of cod (with 49-53 vertebrae) and saith (with 53-56 vertebrae) in both assemblages, however, the higher portion of each range is more apropos (Colley 1983a:268, 276; 1988).

Contrary to Colley's suggestion, the data do not suggest a substantial under-representation of vertebrae in these assemblages. In fairness, she did specifically suggest that caudal vertebrae were underestimated rather than the entire vertebral column. However, given the large proportion of undifferentiated vertebrae in each assemblage (1097 of 4309 gadoid vertebrae from Quoygrew and 678 of 2973 gadoid vertebrae from Tuquoy) it is difficult to make confident assessments regarding such subgroups. Moreover, one would expect small caudal vertebrae to be under-represented at Tuquoy where sieving was not comprehensive (Colley 1983a:330; 1988:1; see Jones 1982; Stewart 1991 and Section 8.4 below for discussions of the relevance of sieving with fine mesh to fish bone recovery).

Vertebrae *were* under-represented in the Viking Age assemblage which Colley (1989) analysed from Brough Road Areas 1 and 2. The data are presented in Figure 1.4 and Table 1.1, following the conventions discussed above. This pattern could conceivably relate to the removal of some bones in cured fish, but recovery may play a role once again. The Brough Road deposits were only partially sieved, and a large mesh size (10mm) was frequently employed (Rackham 1989:232; see Table 5.1).

Information regarding the relative abundance of individual elements is not available for the other Viking Age and Late Norse assemblages Colley has studied (Saevar Howe, Brough of Birsay Sites VII-IX and Beachview), but she does state that all bones were represented at Saevar Howe and Beachview (Colley 1983b:112-113; Rackham et al. forthcoming d). She largely disregards the Brough of Birsay assemblages (Seller 1986) due to extremely poor preservation (Colley 1989:258).

What of other skeletal elements? A brief look at Figure 1.4 reveals, as Colley observed, that appendicular elements (posttemporals, supracleithra and cleithra) *are* under-represented at all three sites in comparison to *some* cranial bones such as dentaries, premaxillae and parasphenoids. As she has also noted, however, the key to interpreting these data is to reach an understanding of how taphonomic processes affect different fish skeletal elements (Colley 1984:125; 1989:255). It is necessary to ensure that butchery models do not correspond to the end product of differential preservation or recovery.

There is some indication within the element frequency data themselves that the pattern Colley identified *could* be a taphonomic bias. While some skull bones are better represented than appendicular elements and vertebrae, others (including elements such as the ceratohyal, quadrate and palatine which are reasonably robust by qualitative assessment) are similarly or even less frequent. In order to argue that the appendicular and trunk elements which Colley specifically mentioned were removed from the assemblages by trade, one might have to assume that these cranial bones were also intentionally cut from the skull for export. This possibility would necessitate a most extraordinary processing method (see Section 8.2 below for a discussion of known fish processing methods in medieval and post-medieval Europe).

As Colley (1984:125) has suggested, the ultimate resolution of this problem may lie in experimental research regarding the relative robustness of different fish elements. Some interesting (if not entirely conclusive) work has been undertaken in this direction (e.g. Bron 1987; Butler & Chatters 1994; A. Jones 1984; 1990; 1991a:78-107; Nicholson 1991; 1992a; 1992b; 1993a; Wheeler & Jones 1989:61-78). The following review is limited to work on cod family fishes given the great inter-taxon variability in fish osteology.

James Bron (1987) examined the relative survival of fish elements by crushing five cod skeletons between a cylindrical steel roller and a flat plywood base. The roller was applied in stages of increasing weight (by filling it with different amounts of water), 38.1kg, 50.8kg and 63.5kg (Bron 1987:28-31). This procedure did not produce the kind of physical damage which is apparent in archaeological assemblages. It tended to leave flat, often fragile, bones intact (e.g. the lacrimal) while destroying robust bones with a more irregular shape, such as the otolith (Bron 1987:41-43). It is difficult to envision an archaeological transformation process which might resemble this kind of intense crushing. Although they provide a useful lesson, Bron's results are probably not a good indication of which elements will survive in most disposal contexts.

Andrew Jones (1991:93-104) trampled a single cod skeleton for 375 paces on a hard surface. He found that the basioccipital, the otolith, the vomer, the parasphenoid, the dentary, the maxilla, the premaxilla, the quadrate, the posttemporal, the opercular and five anterior abdominal vertebra lasted longer than other elements (significantly including the supracleithrum, cleithrum and a majority of the remaining vertebrae). Although a single experiment is less than statistically satisfactory, it provides empirical evidence that the under-representation of supracleithra, cleithra and vertebrae alone may not be sufficient evidence for cured fish production.

A more systematic study was attempted by Rebecca Nicholson (1991; 1992a; 1992b). She subjected two Gadidae taxa, cod and haddock, to physical attrition by tumbling (with gravel, pebbles and ball-bearings) and trampling (on gravel and sand) (see Nicholson 1991:140-248; 1992a:81, 86; 1992b:147 for details). Regrettably, however, the usefulness of her results to the present study is limited in three ways. First, she measures bone destruction by the relative completeness of individual elements, not by the stage at which they became completely unrecognizable. A small robust portion of a bone which may remain recognizable indefinitely could receive a low relative completeness score. Second, only a single cod skeleton was tumbled and only three cod were trampled raising the problem of statistical reliability (Nicholson 1991:187; 1992a:86-87; 1992b:147). Third, although more haddock were used in Nicholson's experiments (Nicholson 1991:144, 187; 1992a:81, 86-87), their skeletal morphology is unlike most gadoid taxa. In particular, hyperostosis of the ventral portion of the cleithrum makes this element anomalously robust (von den Driesch 1994:37-38).

Despite these problems, it is tempting to see the relatively low percentage completeness scores for cod cleithra and caudal vertebrae in the tumbling experiment as corroboration of Jones' results (1992b:Table 3; see Table 1.2). Although Nicholson's trampling experiment might be more analogous to destructive processes on archaeological sites, the percentage completeness scores of most elements are too high to facilitate reasonable assessment of their relative robustness (Nicholson

1991:Table 5:25; see Table 1.2). The sample is not sufficiently damaged to produce a clear picture.

Nicholson has also determined bone density measurements for cod elements (1992b). Attempts to relate true or bulk density and the relative survival of mammal and salmon bones have been moderately successful (e.g. Binford & Bertram 1977; Butler & Chatters 1994; Kreutzer 1992; Lyman 1984; 1994:234-281). Nicholson found, however, that the rank orders produced by approximate measures of both qualities were not correlated with the pattern of bone survival in her tumbling experiment and three archaeological case studies (Nicholson 1992b:147-148). Her explanation - that bone shape and preservation differences among diagnostic zones of single elements are of fundamental importance - is convincing (Nicholson 1992b:148-149). It suggests that unqualified density measurements are of little use for the interpretation of archaeological Gadidae bone distributions.

This experimental evidence is far from conclusive. More replication studies are needed. Nevertheless, the possibility that cleithra and vertebrae are less robust than some skull elements makes it unwise to accept Colley's argument without further corroborating evidence. It may also be relevant that the supracleithrum is a relatively narrow 'pen shaped' bone. It will be subject to poor recovery, particularly in contexts such as Tuquoy and Brough Road Areas 1 and 2 where relatively large mesh sizes were sometimes used (5mm and 10mm respectively) and only some material was sieved (Colley 1983a:330; 1988:1; Rackham 1989:232 see Table 5.1). A quantitative assessment of this problem is attempted in the context of the Robert's Haven assemblage in Section 8.4.2 below.

As a final point, cut marks may provide some evidence to support Colley's interpretation. They do suggest that fish were decapitated and possibly "filleted" (split along the vertebral column) at Brough Road Areas 1 and 2, Saevar Howe, Quoygrew, Tuquoy and Beachview (1983a:215-216, 233-234, 250, 261; 1983c:113, MF102; 1984:127, 129; 1988:4; 1989:255-256; Rackham et al. forthcoming d). This evidence could be consistent with her model of cured fish, particularly if they were only split for part of their length, leaving posterior vertebrae in the exported product. She also acknowledges, however, that these butchery patterns could result from processing for local consumption (Colley 1988).

The evidence of cut marks takes on considerable importance given the taphonomic problems associated with interpreting relative representation of elements data. Before their value can be fully realized, however, it would be useful to construct a model of how one might expect fish to be processed for export. Colley's suggestion that fish heads would be cut off and vertebrae and appendicular elements left in a traded product is reasonable on anatomical grounds. Nevertheless, it *is* an assumption. It would be of value to reconstruct the likely products of medieval cured fish trade using historical, pictorial and archaeological evidence. This issue is considered in Section 8.2 below.

1.3.4 Past Research in Caithness: The Freswick Links project.

Turning to Caithness, Colleen Batey (1989b:226) has suggested in the past that there is evidence for "fishing on a large-scale, possibly even commercially," at the Late Norse site of Freswick Links in Caithness. Some of the site's substantial midden layers consisted almost entirely of fish bone (Batey, 1989b:226; Jones et al. 1983:171; Morris et al. 1992:97; see also Morris 1982:89). After completing analysis of the fish bone assemblage Andrew Jones (1991a; Jones et al. forthcoming b) reached a different conclusion. He suggested that even the fish rich deposits of Freswick could have been produced by domestic level activity (Jones 1991a:340). Jones (e.g. 1991a:289-290, 327-328, 330, 338; see also Jones 1991b:222-226) maintained that taphonomic factors were too destructive for reliable conclusions to be drawn from the fish bone assemblage itself. He turned instead to 18th century historical data regarding Caithness and Orkney (Jones 1991a:312-319). These suggest that fishing was a secondary activity organized at the domestic level for local consumption. He cites records from *The Statistical Account of Scotland 1791-1799*. In the Parish of Kirkwall, Orkney,

> The little farmers on the shores of the Pentland Firth, in the times they could spare from their labour on land, have been known to catch 40,000 fine cod in the space of only one season (Barry 1793:38 in Jones 1991a:314).

Moreover, in Canisbay (the parish in which Freswick is situated),

> not one man lives entirely by fishing but that every farmer in the parish, (the inland estate of Brabster excepted,) is a fisherman and every fisherman a farmer. Boats were jointly owned by 6 or 7 individuals, and fishing was not generally carried out as a commercial activity but in order to support the owners families (paraphrase of Morrison 1793 in Jones 1991a:313).

In the forthcoming final report on investigations at Freswick Links the excavators (Morris et al. forthcoming b) have moved closer to Jones' position. They cite the modest number of bones of large cod family fish represented in each sample from even the richest middens of the site. Given the large number of fish which might be caught for domestic consumption the density and abundance of fish bones at Freswick *could* be the product of fish processing for purely local or regional use. The distinctive deposits at this site need not necessitate the existence of commercial fishing for export.

Although these interpretations are reasonable and cautious they cannot be regarded as conclusive. Reconsideration of the scale of fishing activity represented at Freswick Links is discussed in detail in Chapter 7. However, it is necessary to note here that historical records from the 18th and 19th centuries alone are not appropriate analogies for the character of fishing half a millennium or more earlier. It is particularly relevant that the Orcadian fishery is known to have declined in the eighteenth century (Fenton 1978:595). At this time merchant lairds (land owners) directed the commercial economy towards large scale kelp collecting for English glass and soap manufacturers (Fenton 1978:575; Thomson 1987:199-213). As discussed in Chapter 6, 15 000 dried cod were exported from Caithness in 1329 and as late as 1726, 40 000 cod were shipped from Thurso (Stuart et al. 1878:239; Mitchell 1906:169).

Despite Jones' hesitation regarding the fish bone data from Freswick Links they may be worth a second look. The relative abundance of the four Gadidae elements he systematically identified (cleithra, dentaries, otoliths and premaxillae; see Jones, 1991a:55) are listed in Table 1.3 (compiled from Jones 1991a:Tables 21-24). I have collapsed Jones' taxonomic categories for the sake of clarity. It should be kept in mind, therefore, that both definite and probable identifications are represented by each taxon listed. All phases, including Late Norse *and* Pictish contexts, are combined because a complete chronological breakdown of the assemblage is not available. Given the relatively small size of the Pictish assemblage, however, it is hoped that the results pertain largely to the Late Norse Period (Jones 1991a:328; see Section 5.3.3 below). There is no need in this case to standardize the data for comparative purposes as all four elements occur as one pair per fish.

Several general observations can be made regarding these data. First, otoliths are grossly over-represented. This pattern may be due in part to laboratory procedures in which sorters were asked to select only diagnostic elements from sieved samples (Jones 1991a:51-52). It is not surprising that otoliths, being more distinctive than the other three skeletal elements, are the most abundant. Comparing only cleithra, dentaries, and premaxillae, which may have similar chances of recovery during sorting, cleithra appear to be particularly under-represented in cod and saith/pollack. It is suggestive, however, that they are not under-represented in haddock. As noted above, this taxon has particularly robust cleithra. It is thus entirely possible that the under-representation of this element in the other taxa is a product of taphonomic factors. One alternative explanation, that haddock were processed in a different way, is of course possible. Nevertheless, there is no a priori reason to suspect this. Haddock were prepared as cured fish in a variety of historical contexts (e.g. Austin 1888:114, 146; Cutting 1955:169). Another alternative explanation, that distinctive haddock cleithra were disproportionately recognized during sorting, is more difficult to evaluate.

It may also be relevant that cleithra are considerably less under-represented when all Gadidae taxa are combined. The reason for this is straight-forward; more cleithra were only identified to the family level than premaxillae and dentaries which are quite species diagnostic. Problems of identification, another taphonomic bias, are at least partially responsible for the pattern observable at the species level.

In sum, Jones' hesitation to identify cured fish production and export is understandable. Despite his sizable database, limitations imposed by taphonomic biases, sorting biases and the identification of only four elements makes it difficult to draw firm conclusions.

1.3.5 New Work in the Earldoms: The research of Nicholson and Cerón-Carrasco

Jones' suggestion that there is no evidence for surplus cured fish production in the earldoms was echoed by Rebecca Nicholson (n.d.b) in her study of Iron Age/Viking Age interface (VA1) and Norse (VA2-LN1) assemblages from Pool, Orkney. She found no evidence for a change in the quantity, taxa or sizes of fish between these two periods (see Table 5.6 and Figures 5.33-5.36 for summaries of the primary data). There were few fish remains in pre-interface layers, but she cautiously declined to argue from this negative evidence.

More importantly, Nicholson (n.d.b:30) also suggested that "the fish remains from Pool indicate that entire frames were represented ..." She specifically suggested that the ratio of abdominal to caudal vertebrae was not indicative of selective bone removal. Interestingly, however, the data from Pool exhibit a pattern not unlike that from Colley's sites (compare Tables 1.1 and 1.4, Figures 1.4 and 1.5). Appendicular elements and (in certain cases) vertebrae *are* poorly represented compared to some cranial elements, but nevertheless more abundant than others. The concordance between Nicholson's and Colley's results is confirmed by Spearman's Rank Correlations among the assemblages ranging from 0.823 (Pool phase 7 against Brough Road Areas 1 and 2) to 0.919 (Pool phase 7 against Tuquoy). Nicholson's data are available as proportional representation values, calculated by the formula

$$\frac{\text{observed}}{\text{MNI x expected}} \times 100$$

rather than true bone counts (Nicholson n.d.b:6). Nevertheless, this procedure has a similar effect as dividing element counts by the number of each per fish. The Pool data are therefore comparable (in terms of *relative* abundance and rank order of elements) to Colley's results summarized in Figure 1.4.

Nicholson (n.d.b:25) supported her interpretation that entire fish were present at Pool by arguing that the under-representation of some bones could be entirely explained by taphonomic and recovery processes. The use of large sieves (10mm and 3mm) and hand collecting may be of considerable relevance (see Nicholson n.d.b:3, 25). In conclusion, she suggested that the fish bones from Pool "may represent no more than could be accounted for by local domestic consumption" (Nicholson n.d.b:31).

Nicholson's reluctance to suggest the removal (and potential export) of cured fish from the site is understandable in light of recovery problems. It is evident, however, that assemblages such as Pool (and Freswick Links discussed above) indicate the difficulty of differentiating cultural and taphonomic patterns rather than demonstrating that cured fish were not made and exported. It is necessary to resolve preservation and recovery biases before the latter conclusion could be justified.

Nicholson (n.d.a) has also analysed fish bones from Viking levels of Skaill Deerness. However, she considers the material to be too biased by unsystematic recovery procedures to justify detailed examination (Nicholson pers comm.).

A final study of fish processing in the earldoms, conducted concurrent with this thesis, has recently been published by Ruby Cerón-Carrasco (Cerón-Carrasco 1994; Cerón-Carrasco forthcoming). Late Norse strata at St. Boniface, Papa Westray, were dominated by fish bone (Lowe 1993:30; pers comm.) and, based on qualitative description, may have resembled other possible 'fish midden' deposits at sites such as Sandwick, Quoygrew, Freswick Links and Robert's Haven (see Section 7.2).

On analysis, the fish assemblage exhibited a pattern similar to those observed by Colley and Nicholson. Like Colley, Cerón-Carrasco interpreted an under-representation of cleithra (7 compared to 58 dentaries - the most abundant cranial element) as possible evidence for the export of cured fish (1994:209-210; see Table 1.1 and Figure 1.6). The pattern in this case is quite distinct, with only one other element (the palatine) under-represented to such a severe degree. However, it is notable that supracleithra (which one might expect to be removed with cleithra to which they are articulated) are not particularly under-represented. This pattern is especially interesting given the under-representation of supracleithra in the other assemblages discussed. The difference can almost certainly be attributed to the sieving of all excavated material with 1mm mesh at St. Boniface (Cerón-Carrasco 1994:207; see Table 8.12). The abundance of supracleithra could imply that whole fish were represented at this site, with cleithra under-represented due to preservation bias. Once again, the evidence of relative element abundance is ambiguous.

Cerón-Carrasco also drew attention to cut marks on supracleithra and posttemporals which support the interpretation that fish were decapitated anterior to cleithra (see Figure 1.3). Although suggestive, the qualifications raised above in reference to Colley's butchery data are equally applicable in this context. It would be useful to study the products of medieval fish trade before attributing too much significance to this evidence.

1.3.6 The Current Uncertainty

In summary, the hypothesis that cured fish were produced and exported from the earldoms in the Viking Age or Late Norse Period remains largely unsubstantiated. Bigelow's interpretation of Late Norse Sandwick is suggestive. However, detailed zooarchaeological data which could facilitate independent assessment of his conclusions are not yet available. As discussed above (and in Chapter 6), it is also evident that complimentary evidence used to support patterns observed in the faunal data is not watertight.

Colley's arguments in favour of a commercial fishery, based on data from the Viking Age Brough Road areas and Late Norse Quoygrew and Tuquoy, are problematic. To be logically consistent, her suggestion that fishing for large cod and other Gadidae taxa is indicative of a commercial fishery would also have to be applied to the Mesolithic. Bones of large cod and related taxa, which she interprets as evidence for 'commercial' deep water fishing, have also been recovered from Mesolithic sites such as Morton, Fife. Moreover, the 'under-representation' of appendicular and vertebral elements in some of her assemblages cannot be disentangled from possible taphonomic and recovery biases. Colley's reports of cut marks are suggestive, but it would be helpful to create models of medieval cured fish production before they can be adequately assessed.

The problem of taphonomy, exacerbated by the identification of only four skeletal elements, also makes Jones' study of Late Norse Freswick Links somewhat inconclusive. His claim that fishing was purely a domestic activity is an *assumption* - produced by hesitation to attribute cultural meaning to a bone assemblage affected by taphonomic processes. His use of 18th century analogies as illustrations of Late Norse fishing is misplaced considering the existence of earlier historical evidence for the export of cod from Caithness.

Nicholson adopts Jones' caution. She suggests that Viking Age and Late Norse assemblages from Pool do not demonstrate the removal of processed fish despite the under-representation of some skeletal elements. Once again, the potential of preservation and recovery biases makes it difficult or impossible to differentiate behavioural and taphonomic patterns.

Recent results regarding Late Norse St. Boniface reported by Cerón-Carrasco are also ambiguous. Cleithra do appear to be substantially under-represented *vis-à-vis* cranial elements, but another appendicular element (the supracleithrum) is relatively abundant. While recovery was excellent at this site differential preservation *could* account for the tiny number of cleithra.

1.4 Discussion

Previous attempts to assess the existence and importance of a cured fish trade in the Viking Age and Late Norse earldoms have proven inconclusive, but provide lessons from which future work can learn. They have stumbled on five shortcomings. First, only in the case of Bigelow's work in Shetland has the possible economic role of fish trade been considered in the context of other economic activities. Second, the historical record has been relatively little studied and occasionally inappropriately used. Early records of fish trade regarding the earldoms may (and do, see Chapter 6) come to light. Third, attempts to assess possible chronological changes in the importance of fishing through the Viking Age and Late Norse Period have been complicated by the incomplete integration and publication of different ecofact and artifact assemblages. Fourth, attempts to identify cured fish production using bone evidence have not employed explicit models which might facilitate the recognition of known medieval fish products. Fifth, attempts to identify the possible export of fish products using the relative representation of different skeletal elements have been complicated by preservation and recovery biases.

It is for these reasons that the present study was conceived. It is hoped to overcome some or all of these obstacles. That is,

1) to consider the role of a putative fish trade in the context of other sources of wealth in the Viking Age and Late Norse earldoms of Orkney and Caithness,

2) to briefly review historical evidence regarding the existence and importance of a fish trade in the Viking Age or Late Norse earldoms,

3) to assess the evidence for chronological and spatial variability in the intensity or role of fishing/fish trade in the Viking Age and Late Norse earldoms,

4) to develop models of cured fish production, using historical, pictorial and archaeological data, which may help in the identification of fish processing sites and

5) to report the evidence for or against the production and removal (conceivably for export) of cured fish from Robert's Haven, a Late Norse fish midden in Caithness. Methodological aspects of this project were specifically contrived to attempt to circumvent many problems associated with preservation and recovery biases.

Following this introduction, the thesis is divided into three parts. Part 1 (Chapters 2-4) provides a brief geographical and historical sketch of Viking and Late Norse Orkney, Caithness and Shetland, including a discussion of the relevant sources. It attempts to establish the considerable wealth of the earldoms and the touches on the social context of its acquisition and control.

Part 2 (Chapters 5-6) discusses the possible *sources* of wealth in Norse Orkney and Caithness. In so doing, the section provides an overview of Norse economic activities and synthesises zooarchaeological data of relevance to arguments raised in Part 3. It concludes by highlighting circumstantial evidence for an export trade in cured fish.

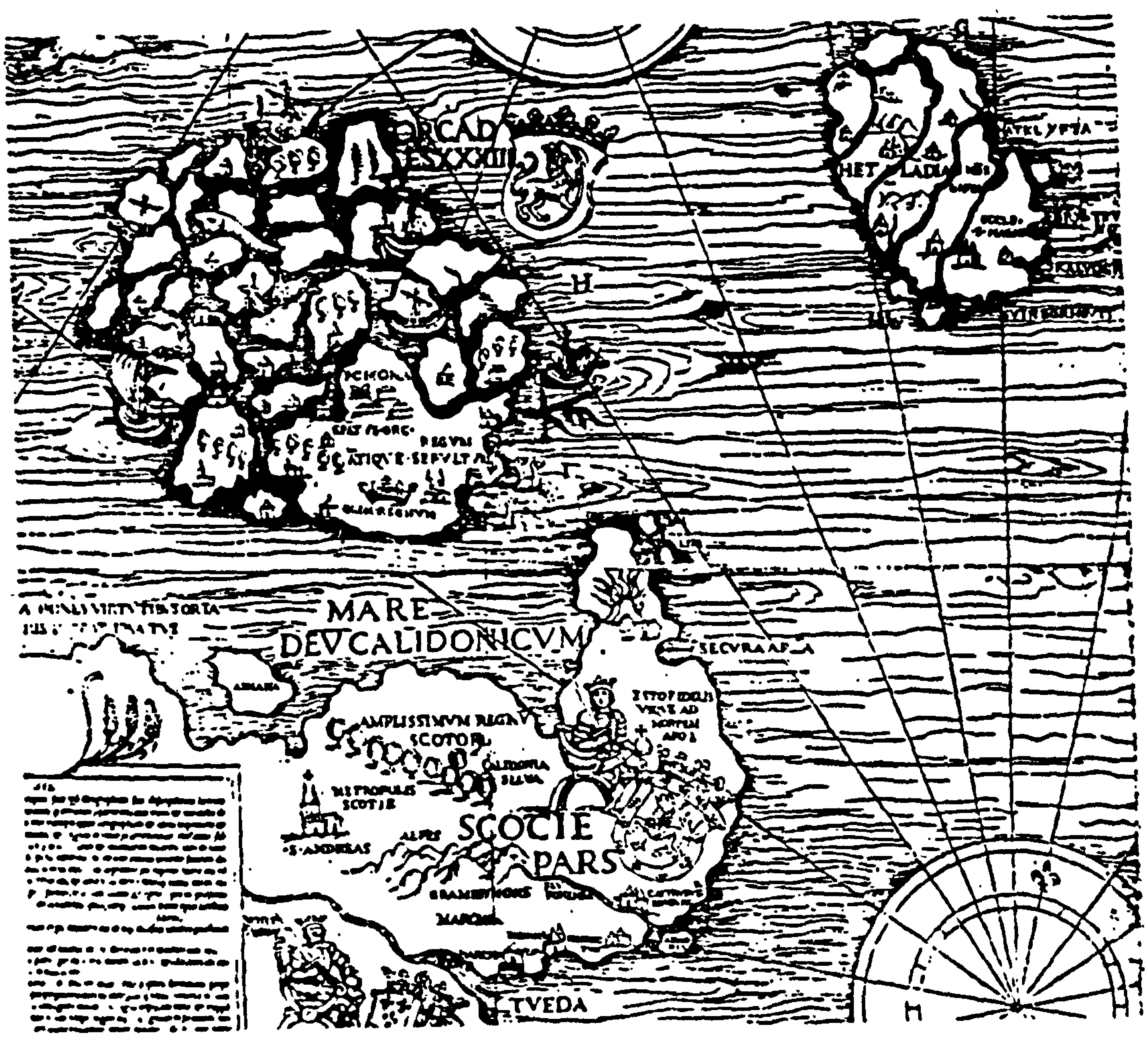
In Part 3 (Chapters 7-9), the existence of two distinct feature types, fish middens and domestic middens, is postulated before one representative of each is compared in detail. Earl's Bu, Orkney, a site which yielded generalised Late Norse household rubbish, is compared with Robert's Haven. The possibility that fish midden sites such as Robert's Haven represent the waste from cured fish production for export is investigated in detail. In concluding Part 3, historical and archaeological evidence are combined to provide a synthesis of socio-economic patterns in Late Norse, and to a lesser degree, Viking, Orkney, Caithness and Shetland.

PART I

THE NORSE EARLDOMS

of

ORKNEY AND CAITHNESS



Chapter 2

The Geographical Context

2.1 Introduction

Having introduced the issue of a putative Viking Age or Late Norse fish trade, it is of value to broaden the focus of inquiry. Chapters 2 and 3 introduce the study area in general terms, surveying the physical geography of the earldoms and the sources by which they may be studied. They form a prelude to the thesis as a whole and, specifically, to Chapter 4 - a protohistorical survey of Viking Age and Late Norse Orkney, Caithness and Shetland.

As briefly discussed in Section 1.2, the geographical boundaries of the study change through time. During much of the Viking Age and Late Norse Period, however, the authority of Orcadian earls may have stretched from Shetland in the north to at least the River Oykel on the Scottish mainland (Crawford 1987:57). This substantial area encompassed three distinct geographical regions:

Shetland,
Orkney and northeastern Caithness and
southern Caithness and Sutherland.

Although broadly similar, the regions are marked by differences in geology, topography and biogeography.

2.2 Geology

For readers unfamiliar with the study area, it is of value to describe the physical setting of the Scandinavian colonies of Scotland. The geographical implications of this setting, in terms of land use potential and marine resources, are pursued further in Sections 2.3-2.6 and in Chapter 5. Shetland, the northernmost extent of the earldoms, is an archipelago of over 100 islands which lies at a mean latitude of 60 degrees North. It has a land area of c.1433km^2 and stretches approximately 112km from north to south and 54km from east to west (Dry & Robertson 1982:3).

The bedrock geology, and consequently the topography, of the Islands is varied and complex (Figures 2.1-2.2). It can be divided into east and west Shetland by the Walls Boundary Fault. The first division, comprising east Mainland, Yell, Whalsay and parts of Unst and Fetlar, is characterised by foliated metamorphic rocks which form rounded north-south ridges and valleys (Mykura 1974:1-2). These ridges are of moderate elevation, largely between 100m and 200m with few peaks over 300m (Dry & Robertson 1982:3).

West of the Walls Boundary Fault a complex combination of plutonic intrusions, metamorphic rock, folded sandstone and volcanic rock all contribute to an undulating and rocky landscape (Dry & Robertson 1982:3; Mykura 1974:2). While much of this topography is below 120m OD (*Ordnance datum* - sea level), Ronas Hill rises to 450m (Dry & Robertson 1982:3).

Two additional geological provinces are also of note. First, Papa Stour, the southeast coast of Mainland and the western coasts of the Walls and Eshaness peninsulas (composed of sandstones, flagstones, conglomerates and Old Red Sandstone lavas) are characterised by gentle topography below c.60m OD (Dry & Robertson 1982:3). Second, most of Fetlar and eastern Unst are characterised by rounded hills of metamorphic rock (serpentinite and metagabbro separated by phyllites and schists) (Mykura 1974:2).

Although the impact of its northern location is somewhat ameliorated by the warming influence of the North Atlantic Drift (see below), Shetland is the least fertile of the three regions. Its landscape is dominated by peat - predominately on gentle to strong slopes - which covers approximately 53% of the land area (Dry & Robertson 1982:13; Jowsey 1973:111). This pattern is thought to have been well advanced several millennia before the centuries of present concern (Bennett et al. 1992:262; Berry & Johnston 1980:75). Peaty soils dominate the remainder of the land area, with a more limited distribution of brown forest soils, noncalcareous gleys, magnesian gleys and calcareous wind blown sands (with associated brown calcareous soils, calcareous gleys and regosols) (Dry & Robertson 1982:13-14).

The coasts of Shetland fall into two distinct categories - inner and outer. The inner coast is a drowned landscape of flooded valleys - voes and firths - created by post-Pleistocene rises in sea level. These channels divide the land to such a degree that no point in Shetland is more than c.5km from the shore (Berry & Johnston 1980:45). The inner coast is sheltered with gently sloping shorelines or, at most, small rock cut cliffs. Peat or glacial till form the beaches where wave energy has been insufficient to erode the drowned land surface. However, rocky shores also occur where superficial deposits have been removed by the sea. This stripping of glacial till has provide raw material for the formation of many sand spits, bars, tombolos and beaches. There are approximately 100 known examples ranging widely in size (Berry & Johnston

1980:45-47). The sand is often calcareous (Berry & Johnston 1980:47) and has produced soils of value for pasture (compare Macaulay Institute for Soil Research 1982b; 1983b) and possibly cereal crops (see Davidson et al. 1986:45; Dry & Robertson 1982:20 for Orcadian analogies). Predictably, the voes and firths of Shetland are relatively shallow, with few exceeding 20m in depth (Hydrographic Office 1993a).

The transition from inner to outer coast is abrupt. The latter is extremely exposed and characterised by rock cliffs reaching c.300m in places. Some cliff-foot beaches do occur. The cliffs generally drop well below sea level, however, falling rapidly to depths of over 50m (Berry & Johnston 1980:49, 52; Hydrographic Office 1993a). After this initial drop the sea floor levels into a plateau (of less than 100m depth) which surrounds the islands for 10-20km on all sides except the south, where it continues to the Scottish mainland. Moreover, the continental shelf, defined as that area less than 200m in depth, extends for another 40-110km west and underlies much of the North Sea (Lee & Ramster 1981:2.00; Hydrographic Office 1993c). The seas around Shetland are swept by ocean currents (the relatively warm waters of the North Atlantic Drift flowing from the Atlantic to the North Sea) and by violent local currents (Goodlad 1971:15; Lee & Ramster 1981:2.10, 2.16). The latter, including Sumburgh Roost, Shaw Strings (north of Unst) and another north of Foula, have been favoured saith fishing grounds in the recent past (Berry & Johnston 1980:94). The sea floor surrounding Shetland is characterised by rock, sand and gravel (Lee & Ramster 1981:2.01).

Orkney, an archipelago of approximately 70 islands (Berry 1985:17), straddles 59 degrees North latitude. It lies c.80km south of the principal Island of Shetland and 10km north of the Scottish mainland from which it is clearly visible. The islands extend for approximately 85km from north to south, 37km from east to west and comprise c.100 000 hectares (over half of which is contributed by a single island, Mainland) (Berry 1985:17-18). Their bedrock geology consists primarily of Old Red Sandstone which is largely covered by glacial till (with an average thickness of 120cm) (Dry & Robertson 1982:2). The relief of Orkney is moderate, with most land below 150m OD. However, western Mainland and much of Rousay are hilly (elevations to 270m OD) and parts of Hoy are mountainous (reaching 477m OD) (Davidson & Jones 1985:12).

Orkney is essentially a continuation the northeastern region of Caithness, the Caithness Plain (Berry 1985:35; Futty & Towers 1982:6-7). The islands and mainland share a common bedrock and drift geology, topography and pedology (Dry & Robertson 1982:1-2, 12). Soils in both areas are dominated by noncalcareous gleys (c.40%), peat (c.20%, primarily in elevated areas), brown forest soils (c.15%) and peaty gleys (c.12%) (Dry & Robertson 1982:12; Futty & Towers 1982:7). Calcareous windblown sands also occur. In Orkney, these are important on the islands of Sanday, Westray and North Ronaldsay and at Skaill Bay and Birsay Bay, Mainland (Dry & Robertson 1982:12). The primary Caithness examples include Dunnet, Keiss, Freswick, John O' Groats (including Robert's Haven) and Sandside Bay (Futty & Towers 1982:6-7; Ritchie & Mather 1970:Figure 1).

Two important landscape differences distinguish Orkney and the Caithness Plain, the relative importance of rivers and coast. Substantial rivers and river valleys occur only in Caithness (e.g. Halladale River, River Thurso, Wick River, Dunbeath Water, Berriedale Water and Langwell Water). Eighteenth century cartographic evidence suggests that these valleys and waterways were foci of agriculture prior to the introduction of modern farming methods (O'Dell 1953; see Figures 1.2 and 2.4). They probably also served as key communication routes prior to substantial road construction projects in the 18th-19th centuries (Watson 1989:182).

Conversely, the Orkney islands are more dominated by coast and sea. The former extends for c.800km, half the coastline of mainland Scotland. Approximately 20% is characterised by cliffs over 15m in elevation (50% on the Orkney Mainland) and 11% by sand and shingle beaches (Berry 1985:45-46). It is impossible to be more than a few kilometers from the sea anywhere in Orkney and only a few historical townships (principally in west Mainland) lack shoreline (see Simpson 1994). Much of the shore is sheltered, particularly on Scapa Flow and straits between islands (Berry 1985:46). Access to the sea is thus largely unrestricted, a factor which emphasises the distinction from land based resources which can be more closely controlled (see Section 5.6).

Coastal morphology below the shoreline varies considerably. In the south and west the shore drops quickly to depths of 20-50m (Hydrographic Office 1993a). Conversely, the beds of Scapa Flow and many inter-island firths or sounds are seldom more than 9m deep (Berry 1985:88). The complex interaction of Atlantic and North Sea tidal systems creates vigorous currents among and around the islands. The tidal race in the Pentland Firth, for example, reaches speeds of nine knots. Bottom deposits are therefore typically of sand, shell-gravel or rock rather than mud (Berry 1985:88-89; Lee & Ramster 1981:2.10).

The shoreline of northeastern Caithness resembles Orkney - there is simply less of it. Although much usable land in Caithness is coastal, a substantial proportion (along the Rivers Wick and Thurso for example) is more than 10km from the shore (see Figures 2.3 and 2.4). Like Orkney, the coast is characterised by areas of both vertical cliff and gently sloping beach. However, shelter is less ubiquitous in Caithness outwith sandy bays and rocky inlets or "geos". Deep waters are also closer to shore than in the sheltered firths of Orkney. Bays excepted, the coast drops steeply to depths of greater than 36m. The bed of the Pentland Firth is predominantly characterised by rock, while shell and sand are more common off the east coast (Lee & Ramster 1981:2.01; Ritchie & Mather 1970:6-7, Figure 4a).

From the coasts of Orkney and northeastern Caithness a sea floor plateau of less than 100m depth extends for 43-74km to the east, 11-32km to the west and past Shetland in the North. Beyond it, the boundary of the continental shelf (200m) is at least (and often much farther than) 122km from shore (Hydrographic Office 1993a; 1993c).

Southern Caithness and Sutherland can be divided into three physiographic regions: the west Northern Highlands, the east Northern Highlands and the Moray Firth Lowlands (Futty & Towers 1982:1-5). The west Northern Highlands constitute that part of Sutherland west of the Moine Thrust - essentially the western and northern seaboard. This region can in turn be considered as two divisions. The first includes a strip of mountainous country to the west of the Moine Thrust. The second division is the western lowlands, an indented, rugged and rocky coastline predominately below 200m in elevation. Much of the bedrock is exposed, although glacial till does occur in some areas. Peat cover is also common (Futty & Towers 1982:4, 16).

Both western and northern coasts of the west Northern Highlands are indented by sea lochs resembling Norwegian fjords (Knowlton 1974:50). Like Shetland, cliffs are common on the outer coast, although horizontal rock exposures also occur. The inner coasts of lochs and bays are more gentle, often with substantial sand beaches (Ordnance Survey 1984; 1988; 1993). Below the shoreline the coast drops relatively steeply to 20m - with the exception of sea lochs, bays and the straits around coastal islands where water depths are sometimes more shallow (Hydrographic Office 1993d). A broad continental shelf extends westward from this depth, reaching its 200m terminus beyond the outer Hebrides (Hydrographic Office 1993b; Lee & Ramster 1981:2.00). Sea floor sediments directly off the northern and western coasts include rock, sand and gravel (Lee & Ramster 1981:2.01).

The east Northern Highlands include that area between the Moine Thrust to the west, the Caithness Plain to the northeast, and the Moray Firth Lowlands to the southeast (Futty & Towers 1982:1-5). They have appropriately been described as the central plateau (Ross et al. 1982:47). The relief is predominately gentle, between 50 and 250m in elevation, and till covered. However, some slopes are strong and mountainous areas occur in both central and north-west Sutherland (Futty & Towers 1982:5). The Ord of Caithness, for example, presents a physical boundary between eastern Sutherland and the Caithness Plain (Ordnance Survey 1989). Like northeastern Caithness, the region is dissected by rivers (e.g. River Loanan, River Laxford, River Dionard, Strathmore River, Kinloch River, River Naver, Halladale River, River Helmsdale, River Brora, River Fleet and River Oykel) and their valleys along which agriculture was common in the 18th century (O'Dell 1953; see Figure 2.4). Outwith these oases, much of the east Northern Highlands are peat covered moorland (Futty & Towers 1982:5, 16).

The most fertile region of Sutherland is the Moray Firth Lowlands along the east coast. The bedrock geology is variable, but predominantly of Old Red, Permo-Triassic, Triassic and Jurassic sandstones. Relief is moderate (with elevations largely below 60m), but the undulating plateau is cut by river valleys. The drift geology consists of fluvio-glacial sands and gravels, raised beach deposits, some glacial till and (on the coastline) windblown sands (Futty & Towers 1982:7). These have developed into humus-iron podzols, brown forest soils, regosols and (in river valleys) alluvial soils (Macaulay Institute for Soil Research 1982a). The coast resembles that of the Caithness Plain and Orkney, which share the same bedrock geology (Gillen 1986:20). Long sandy beaches are particularly common. Beyond the shore the bed of the Dornoch Firth and North Sea remain relatively shallow (less than 50m and 100m respectively) (Hydrographic Office 1993c; Lee & Ramster 1981:2.00).

2.3 Vegetation and Land Use

Cultivated ground in Shetland is predominately restricted to coastal areas, to soils derived from calcareous sands, to the magnesian gleys of Unst and Fetlar and to soils on limestone (see Figure 2.3). Only hay is harvested from peat and peaty gleys (Dry & Robertson 1982:13-14, 16-18). The remainder of the Shetland landscape consists of rough grassland communities, heath and moorland - all of potential use for grazing (Dry & Robertson 1982:17-18, 20; see Kaland 1987:172-173 for a medieval Norwegian analogy). As of 1982, c.93% of the land area of Shetland was classed as rough grazings (principally for sheep). The remaining seven percent was divided unevenly between grass (75%), oats (5%), potatoes (3%) and other uses (Dry & Robertson 1982:20). However, the possibility that more marginal areas were cultivated in the past should not be overlooked (see discussion regarding Orkney in Davidson & Jones 1985:16-17).

The present distribution of vegetation in Shetland is affected by climatic, soil and land use factors. The archipelago's most noticeable feature, shared with Orkney and northeast Caithness, is the virtual absence of forest cover. Excluding probable recent introductions, six taxa of small tree presently occur in Shetland (juniper, *Juniperus communis*, rowan, *Sorbus aucuparia*, birch, *Betula pubescens*, hazel, *Corylus avellana*, aspen, *Populus tremula* and willow, *Salix* spp.). However, they have all been largely confined to inaccessible ledges and islands by grazing pressure (Berry & Johnston 1980:88, 283, 289, 292). The antiquity of this virtually treeless landscape is confirmed by palynology (e.g. Bennett et al. 1992:262) and is of considerable palaeoeconomic importance. In cases where the use of driftwood can be ruled out, such as the precise requirements of boat building, archaeological evidence for non-native species or substantial timbers provides useful information regarding possible long-range exchange (see Section 6.8.2).

The proportion of arable land in Orkney and the Caithness Plain is much greater than in Shetland (c.37% for Orkney [O'Dell 1939:270]; see Figure 2.3). However, any relevance of this pattern to past agricultural potential must be interpreted against a background of substantial modern improvements through land drainage and the application of fertilizers (Davidson & Jones 1985:16-17). Modern crops include grass for fodder, barley, oats, swedes, turnips and potatoes (Dry & Robertson 1982:20). Natural rough grassland occurs on hill slopes while moorland floral communities are common on the peaty soils of cool elevated areas (where low evaporation rates maintain wet conditions [Futty & Towers 1982:8-11]) (Dry & Robertson 1982:14-15). Distinctive plant communities (including oat fields) are also associated with soils on calcareous sand deposits (Dry & Robertson 1982:14-15, 20).

Orkney and the Caithness Plain have probably been largely treeless for at least 2500 years (Donaldson & Jones 1985:25; Huntley forthcoming; Peglar 1979:260; see also Charman 1994:167). Nevertheless, localised natural woodland does occur - on Hoy in Orkney for example (Dry & Robertson 1982:16). The identification of native tree species in Orkney is still a matter of debate, but a tentative list might include willow (*Salix* spp.), birch (*Betula pubescens*), rowan (*Sorbus aucuparia*), aspen (*Populus tremula*) and hazel (*Corylus avellana*) (Berry 1985:71-72; Donaldson & Jones 1985:25; Dry & Robertson 1982:16). With the addition of alder (*Alnus*), ash (*Fraxinus*) and oak (*Quercus*), a similar list applies to the Caithness Plain (although more substantial woodland occurs in western Sutherland, see below) (Donaldson 1986b:220; Dry & Robertson 1982:16; Huntley forthcoming; Peglar 1979:Figure 3). Wood thus provides the same potential for tracing exchange patterns as it does in Shetland (see Section 6.8.2).

Much of the west Northern Highlands are characterised by moorland vegetation and are currently usable only for grazing (Macaulay Institute for Soil Research 1983a; see Figure 2.3). Some arable agriculture, however, is indicated by 18th century cartographic evidence (O'Dell 1953; see Figure 2.4). The east Northern Highlands (or central plateau) are also predominantly peat covered moorland - suitable only for rough grazing (Futty & Towers 1982:5, 16; Macaulay Institute for Soil Research 1983a). As mentioned above, however, agriculture was practised along several river valleys in the 18th century (O'Dell 1953; see Figure 2.4). Grassland vegetation is common in the Moray Firth Lowlands and this region is now extensively cultivated (Futty & Towers 1982:18).

The past and present forest resources of western Sutherland are relatively substantial (Baldwin 1986:193; Charman 1994:167; Futty & Towers 1982:19-20). Remnants of native pinewood still survive and some oak and birch wood and ash-oak wood are probably also relics of natural vegetation. In eastern Caithness and Sutherland hazel dominates the woodland of gullies and valleys where (often scrub) communities including species such as alder, willow and birch are also found (Futty & Towers 1982:19-20).

2.4 Terrestrial and Freshwater Fauna

All terrestrial mammals in Shetland must have been introduced since the Ice Age, and many probably owe their arrival to the last four centuries. The latter category includes the hedgehog (*Erinaceus europaeus*) introduced c.1860, the brown hare (*Lepus europaeus*) introduced c.1830 and the mountain hare (*Lepus timidus*) introduced c.1900 (Berry & Johnston 1980:128-131). The stoat (*Mustela erminea*), the rabbit (*Oryctolagus cuniculus*) and the ship (or black) rat (*Rattus rattus*) are all recorded in seventeenth century Shetland, but the antiquity of their introduction remains to be established archaeologically (Berry & Johnston 1980:129-131; note their absence in Bigelow 1984:Tables 11-12; Grahame 1968; Noddle 1986; Platt 1956). The date at which wood (or field) mice (*Apodemus sylvaticus*), house mice (*Mus musculus*) and common (or brown) rats (*Rattus norvegicus*) reached the archipelago is unknown (Berry & Johnston 1980:129-137). Of all the wild terrestrial mammals currently in Shetland only the otter (*Lutra lutra*) has been recovered from a Norse archaeological context (Bigelow 1984:Table 12). The few (possibly only four) unworked red deer (*Cervus elaphus*) specimens recovered from Neolithic and Norse contexts in Shetland (Noddle 1986:132; Platt 1956:213-214) were probably imported. At least one of the elements was antler (Noddle 1986:132), of potential value for the manufacture of artifacts such as combs.

Domestic animals are thus the only terrestrial mammals of potential importance to Norse Shetland. Sheep, cattle, pigs, horses, dogs and cats are all recorded from Norse archaeological contexts (Bigelow 1984:Tables 11-12; Platt 1956). Traditional

Shetlandic breeds of cattle and sheep still survive, providing useful analogs for Norse livestock (Berry & Johnston 1980:138-139).

Like terrestrial mammals, the diversity of freshwater fish in Shetland is limited. Lochs are frequent (c.195), and virtually all sustain brown trout (*Salmo trutta*) (Berry & Johnston 1980:118, 125). Sea trout (the anadromous population of *Salmo trutta*) also occur in burns and lochs accessible from the sea (Berry 1985:111; Berry & Johnston 1980:125). Only a few streams (Scottish *burns*) are suitable for the freshwater migration of Salmon (*Salmo salar*). Char (*Salvelinus alpinus*) has an extremely restricted distribution, but eels (*Anguilla anguilla*) and the three-spined stickleback (*Gasterosteus aculeatus*) are ubiquitous (Berry & Johnston 1980:125). Several additional species are primarily marine, but also inhabit estuaries and penetrate into fresh water. These include sturgeon (*Acipenser sturio*), common goby (*Pomatoschistus microps*), thick- and thin-lipped mullets (*Chelon labrosus*, *Liza ramada*) and flounder (*Platichthys flesus*) (Maitland & Campbell 1992:323-329).

Orkney's limited range of terrestrial mammals is comparable with Shetland. The only significant differences include indigenous populations of Orkney vole (*Microtus arvalis*), mountain hare (restricted to Hoy), pygmy shrew (*Sorex minutus*), and red deer (Berry 1985:130-133; see also Rackham 1989:MF4G6 regarding rabbit and brown hare). Red deer may have been introduced to the islands by humans in the Neolithic (Clutton-Brock 1979a:120) and probably become extinct shortly before or during the Viking Age (Hunter et al. 1990:188; 1993:282).

The terrestrial fauna of Caithness and Sutherland is slightly more diverse. The mammals resemble those of Northern Britain as a whole (see Corbet & Southern 1977). However, the presence of carnivores such as wolves (*Canis lupus*) and foxes (*Vulpes vulpes*) on the mainland deserves special note (see Pennie 1982b:119 regarding the 18th century extirpation of wolves from northern Scotland). Fox has been found in Neolithic contexts in Orkney, but seems only to have survived into the Viking Age and present on the Scottish mainland (Clutton-Brock 1979a:117; Pennie 1982b:124). The presence of carnivores on the Scottish mainland must have necessitated more rigorous shepherding strategies than would have been required in Orkney and Shetland (see Sephton 1899:246 for a medieval Norwegian analogy).

2.5 Marine and Avian Fauna

Shetland's somewhat limited terrestrial resources are compensated by rich marine fish stocks, whale stocks, seal pupping and basking grounds, mollusc populations and seabird colonies. Some or all of the above have probably contributed to the islands' economy from at least the Iron Age to the present century (e.g. Bigelow 1984:Tables 11-12; Cerón-Carrasco n.d.; Fenton 1978:510-551, 571-584, 595-615; Grahame 1968; Platt 1956).

Marine fish resources encompass a wide diversity of species found from the littoral zone to deep water beyond the continental slope. Wheeler's (1978a) survey of fishes in Northern European waters lists over 350 species. However, relatively few of these have been foci of human exploitation. In recent centuries, fishing in Scottish waters has focused on herring and members of the cod family, Gadidae (Gray 1978). Moreover, only the latter occur with any frequency in middens of Viking Age and Late Norse date (see Section 5.6). Five gadoid fishes were evidently of particular importance during the centuries of concern: cod, saith, haddock, ling and torsk. All are widely distributed demersal (bottom living) fishes which grow to considerable sizes (see Figure 2.6). Muus and Dahlstrøm (1974:98, 114) list the maximum size of cod as 1.5m while ling, the largest member of the family Gadidae, can reach lengths of 1.8m.

Cod are found from the shore to depths of 600m over a wide variety of sea floor conditions (Goodlad 1971:37; Whitehead et al. 1986a:686). They are frequent even in the sea lochs of western Sutherland (Knowlton 1974:55-56). However, large individuals generally inhabit deeper waters than young fish (Wheeler 1978a:150). The famous migratory cod populations of Norway do not enter Shetlandic, Orcadian or mainland Scottish waters (Garrod 1977:217), but coastal and North Sea stocks are available on a year-round basis (Lee & Ramster 1981:3.06; Muus and Dahlstrøm 1974:98-102; see Figure 2.6). Coastal cod do undergo local migrations (Lee & Ramster 1981:3.06), but these have changed even in the last century (Goodlad 1971:37). They cannot be confidently extrapolated to the Viking Age or Late Norse Period.

Saith are also found over a variety of sea floors - from the shore to considerable depths (200m) (Goodlad 1971:38; Whitehead et al 1986a:691; see Figure 2.6). Young fish are often very common close inshore in Scottish waters (Baldwin 1982; Coull et al. 1979:25-26; Knowlton 1974:56; Wheeler 1978a:159-160). Larger individuals are typically found in greater depths, particularly during the spring spawning season (Coull et al. 1979:25-26; Wheeler 1978a:159-160). However, they have also been fished from strong currents close to shore (Goodlad 1971:38). Saith do undertake seasonal migrations, but these have had an impact primarily on the availability of young fish. In recent centuries large numbers of one to three year old saith have been caught particularly close to shore during the summer and autumn (Baldwin 1982; see Low 1813:193-194).

Haddock are similarly indifferent to sea floor conditions and can be found from slightly deeper waters (30m) to depths of 300m (Colley 1983a:385, 387; Goodlad 1971:36; Whitehead et al. 1986a:687; see Figure 2.6). While they are unlikely to be abundant in shallow inter-island waters and voes, haddock have been taken within two kilometers of shore (in deep water immediately to the south and west of Orkney, for example) (Colley 1983a:385, 387; Goodlad 1971:36). Their seasonal movements may be more noticeable than those of cod, with an offshore migration during the spawning period from March to April (Wheeler 1978a:152-153). Haddock are rare in Shetlandic and Orcadian waters during these months (Colley 1983a:169; Goodlad 1971:36).

Today ling are generally found in depths of over 300-400m (Whitehead et al. 1986a:703). As discussed in Chapter 1, however, this may not always have been the case (see Brand 1883[1701]:193-194). Moreover, immature specimens are still found in shallow waters, particularly over wrecks and rocky ground (Wheeler 1978a:167; Whitehead et al. 1986a:703). Torsk are similarly classified as a deep water fish, typically inhabiting depths of 100-1000m over rocky ground (Whitehead et al. 1986a:697). They too, however, can occasionally be found in somewhat more shallow waters (50m for example) (Wheeler 1978a:162).

It is difficult to locate potential fish resources more precisely. Ling, tusk and haddock may be expected to avoid shallow firths and voes. In the case of ling, however, there is anecdotal historical evidence that this was not always so. Ling and tusk also favour rocky bottoms, but these are ubiquitous in the seas around Shetland, Orkney and northern Scotland and do not prove to be a useful limiting factor (Lee & Ramster 1981:2.01). Moreover, the level of detail provided by sea floor maps is of little use in pinpointing foci in fish distributions which can be as localised as a wreck site (e.g. Wheeler 1978a:167).

Maps of recent fishing locations (e.g. Goodlad 1971:258; Lee & Ramster 1981:3.00) are also of minimal use. They have as much to do with soft flat sea floors conducive to seine net technology as with fish distributions. These sources "give an unbalanced view of the abundance of fish and their distribution" if hook and line were the available tools (Goodlad 1971:34; see Section 5.6). Early 20th century maps of fishing grounds do include areas suitable for lines. However, they concentrate on offshore banks and provide no information regarding waters within c.20km of land (e.g. Close 1922). This is not surprising given that the charts existed as navigational aids for unfamiliar waters.

Despite this uncertainty regarding the location of pre-modern fishing grounds it can be assumed that they did exist. As mentioned above, strong local currents were particularly favoured for catching saith in recent centuries. One known current, Sumburgh Roost off southern Shetland, may even be described in a saga anecdote regarding the 11th century (Pálsson & Edwards 1981:159; see Section 5.6 below). It is also known that fishing grounds were located in the 19th century through the use of cross bearings from landmarks known as *meiths* (Goodlad 1971:101). Most fishing in that century was thus carried out within easy sight of shore. However, grounds near the edge of the continental shelf, as far as 80km from Shetland, were fished from traditional open boats in the 1880s. At this point, only the summit of Ronas Hill (450m) was visible above the horizon (Goodlad 1971:101-102).

In sum, it may only be possible to make broad generalizations regarding the accessibility of fish resources in the Viking Age and Late Norse Period. Large cod, saith and ling were probably more abundant in deeper water than immature fish of the same taxa. Large saith may also have been found in strong currents. Torsk (which is relatively infrequent in Norse faunal assemblages, see Table 5.6) may well have been caught in the deepest waters fished - or to the north and west of Shetland where the 100m contour is relatively close to land (see Figure 2.5). Lastly, haddock were perhaps less available during their spring spawning season.

The cetacean stocks of northern British waters are also diverse, with 23 species recorded by Evans (1980:1). During recent centuries in both Shetland and Orkney whales have been utilized by scavenging natural strandings (potentially of a wide variety of taxa) and by active drives of whale pods (particularly pilot whales, *Globicephala melas*) into shallow water (Berry & Johnston 1980:104-107; Fenton 1978:545-550). Two seal species, the common (*Phoca vitulina*) and grey (*Halichoerus grypus*) frequent the coasts and skerries of Shetland (see Figure 2.7). They are particularly vulnerable while hauled out, either to bask or during pupping season (June for common seals and October/November for grey seals) (Berry & Johnston 1980:109-110, 113). The marine Mollusca of Northern Britain are diverse and plentiful (see Berry 1985:278-283). Although their nutritional potential is small (e.g. Evans & Spencer 1976-1977:215-216), they have served as important sources of fish bait and famine food in recent centuries (Fenton 1986a:123-125; 1992).

Approximately 63 bird species regularly breed in Shetland, including both terrestrial taxa and vast colonies of sea birds (Berry & Johnston 1980:149; see Figure 2.8). The latter include (among others) the fulmar (*Fulmarus glacialis*), manx shearwater (*Puffinus puffinus*), gannets (*Morus bassana*), kittiwakes (*Larus tridactylus*), puffins (*Fratercula arctica*), guillemots (*Uria aalge*), gulls (*Larus* spp.), terns (*Sterna* spp.), shags (*Phalacrocorax aristotelis*) and cormorants (*Phalacrocorax carbo*) (Berry &

Johnston 1980:315-344). These local populations are also supplemented by passing migrants (e.g. Berry & Johnston 1980:149, 219-232).

Orkney and (coastal) mainland Scotland are also well situated for the exploitation of fish, whales, seals, birds and marine molluscs (Berry 1985:91-109, 136-162, 278-281; Evans 1980; Pennie 1982a; 1982b; Whitehead et al. 1986a; see Figures 2.6 and 2.8). These resources are largely comparable to those in Shetland, but some differences are evident in the distribution of bird and freshwater fish taxa. The freshwater and anadromous fish of Shetland and Orkney are identical (see Berry 1985:110-122; Berry & Johnston 1980:125-126; Maitland & Campbell 1992:323-329). However, a few additional taxa occur in Caithness and/or Sutherland. Sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and brook lamprey (*Lampetra planeri*) occur in southeast Sutherland. The range of pike (*Esox lucius*) and perch (*Perca fluviatilis*) may also include the lochs, streams and rivers of southern Sutherland (Maitland & Campbell 1992:169, 281). The latter taxa, however, is perhaps a relatively recent introduction (Maitland & Campbell 1992:281). Sea bass (*Dicentrarchus labrax*) sometimes venture into large rivers where they may be found in Caithness and Sutherland (Maitland & Campbell 1992:267, 328).

Twenty-nine bird species which are not common in Shetland breed regularly in Orkney (Berry 1985:136). Some are predators of small mammals and may be excluded from Shetland by the absence of voles (Berry 1985:138-139). Similarly, 36 species which breed in Caithness and Sutherland do not do so in Orkney. Many of these taxa are dependent on trees (Berry 1985:138).

2.6 Climate and Environmental Change

Having briefly introduced the geology, relief, soils, flora and fauna of the study areas, a general discussion of weather and climate is in order. The vegetation and land use potential of northern Scotland is limited by dampness, low summer temperatures and high winds (Dry & Robertson 1982:9-12; 61-62; Futty & Towers 1982:7-11). Virtually all areas are under a maritime influence, which maintains a small range in annual temperatures (Dry & Robertson 1982:9; Futty & Towers 1982:9). Frost and snow are relatively infrequent in all but mountainous environments (Berry 1985:20; Berry & Johnston 1980:21-26; Futty & Towers 1982:9). In Shetland, for example, snow falls on an average of 40 days a year but rarely covers ground for more than twenty (Berry & Johnston 1980:26). Rain is a frequent occurrence (almost daily in some seasons) - particularly in the west Northern Highlands (Berry 1985:22; Berry & Johnston 1980:22; Futty & Towers 1982:8-9). However, the widespread damp conditions are due as much to cool summer temperatures - and thus low evaporation rates - as to high precipitation (Dry & Robertson 1982:9; Futty & Towers 1982:9; see Figure 2.2). It is interesting to note in this regard that some of the most highly valued land in early 16th century Orkney was on free draining soils derived from windblown sand deposits (Davidson et al. 1986:45). High winds are an important limiting factor on vegetation - particularly in Shetland, Orkney, the Caithness Plain and hilly areas of western and northern Sutherland (Davidson et al. 1985:15, 17; Dry & Robertson 1982:9; Futty & Towers 1982:9-10).

Changes in landscape and climate over the past two millennia are a matter of ongoing debate. Nevertheless, several important features are relatively well established. As noted above, peat growth probably began several thousand years before the Norse colonisation of Scotland (Bennett et al. 1992:262; Davidson & Jones 1985:28; Huntley forthcoming; Peglar 1979:259-260). However, modern drainage and land improvement (in Orkney and the Caithness Plain [Thomson 1987:226-227; Miller 1989b:104-105]) and the abandonment of agriculturally marginal land (particularly in Sutherland [Withrington 1982]) ensures that distinctions between arable and rough grazing land described above may misrepresent the medieval situation. For mainland Scotland, the late 18th century Military Survey provides a useful picture of the extent of arable land prior to modern agricultural changes (O'Dell 1953; see Figure 2.4). The virtually treeless environments of Shetland, Orkney and the Caithness Plain are also pre-Norse in origin. Whether due to human clearance and herbivore grazing or natural processes this pattern probably dates to the Neolithic, Bronze Age and early Iron Age (Bennett et al. 1992:262; Berry 1985:48, 71-72; Berry & Johnston 1980:88; Davidson & Jones 1985:25-27; Huntley forthcoming; Peglar 1979:260).

Possible changes in agricultural potential during a putative 'Medieval Warm Period' (c.10th-14th or 15th centuries?) and subsequent 'Little Ice Age' (c. 14th or 15th -19th centuries?) are difficult to model. The chronology, scale and continuity of these phenomena are issues of considerable uncertainty and local variability (Grove 1988; Hughes & Diaz 1994). Nevertheless, it is apparent that some degree of climatic deterioration characterised the later Middle Ages in northwestern Europe. It has been suggested that these changes played a major role in the decline of Norse Greenland (McGovern 1980; 1994) and the late medieval/early modern economic crisis in Iceland (Buckland et al. 1994; McGovern et al. 1988). Moreover, late medieval phases of land abandonment in England and southeast Scotland have been correlated with climate change (Grove 1988:407-415). The studies of Parry (1975; 1976; 1978; Parry & Carter 1985) in southeast Scotland provide a useful analog for Orkney, Caithness and Shetland. They provide evidence for abandonment of upland settlement between the 14th and 16th centuries (Parry 1975). The critical factor may have been the probability of harvest failure, particularly in consecutive years. This is largely controlled by the length and temperature of the growing season (measured in day-degrees) which varies with altitude.

Thomas McGovern and colleagues (1988) have attempted to predict the effect of climatic deterioration on North Atlantic agricultural regimes using a similar approach. They suggest that Shetland (and by implication Orkney and mainland Scotland) receive sufficient accumulated temperature per growing season (in day-degrees over 5.1°c and 4.4°c) to continue barley and hay production in the face of minor climatic changes (McGovern et al. 1988:235). Given the results from more southerly Scottish and English settlements, however, it can probably be assumed that land marginal for cereal cultivation (particularly in cool upland areas, see Figure 2.2) became unworkable in the Little Ice Age. There may be evidence to this effect in Orcadian records from the late 15th and early 16th centuries when previously rented land lay out of cultivation (Thomson 1984:131).

There is also evidence that marine resources, specifically cod stocks, were affected by the Little Ice Age. The Icelandic and Norwegian fisheries declined in the 17th century and failed as far south as Stavanger in 1695 (Grove 1988:392). This catastrophe could be explained by a southward extension of polar water below 2°C (displacing the usual flow of the warmer North Atlantic Drift). Cod cannot survive in temperatures below 2°C and reproduce between 4 and 7°C (Grove 1988:391-392). The potential impact of water temperature on cod stocks is illustrated by well recorded modern fluctuations in the distribution of this species around Greenland (Grove 1988:392-393).

These examples demonstrate the potential effect of climate on the availability of the single most abundant fish in Viking Age and Late Norse middens (see Table 5.6). They do not, however, provide direct evidence for the centuries of present concern. Although the Little Ice Age *may* have begun in the late 13th or 14th century (see below), this was the period during which Icelandic and Norwegian fish exports were actually at their height (Gelsinger 1981:181-194; Nedkvitne 1976) - a pattern which continued into the 15th century (Þorsteinsson 1969). Climatic deterioration may ultimately have led to deterioration of the North Atlantic fisheries. However, this eventuality was still far in the future as the Late Norse Period drew to a close. Possible climatic impacts on more vulnerable agricultural resources may actually have increased the importance of fishing.

The potential socioeconomic impact of climatic deterioration cannot be denied. In the context of the current study, however, timing is everything. If cooling began in the 14th century or earlier it may be of considerable relevance - to the relative importance of arable agriculture and fishing for example. If it did not start until the 15th century, the Little Ice Age is of minimal current concern. The issue of chronology presents a significant problem. The dating of medieval climate change is open to great uncertainty. It may have affected different regions at different times (Dansgaard et al. 1975) and different proxy climate indicators provide different results. For example, historical records of sea ice and cold seasons in Iceland are consistent with cooling in the late 12th to 14th centuries (Ogilvie 1991:249) while a recent synthesis of palaeoclimatic indicators such as tree growth and glaciation suggests a 15th century date (Hughes & Diaz 1994:136). One can take some comfort, however, in the fact that both represent the chronological limits of the Late Norse Period. While possible 13th-14th century climate changes cannot be completely ignored (see Chapter 9), the fraught issue of dating the Little Ice Age is largely outwith the boundaries of this study.

2.7 Chapter Summary

Chapter 2 has attempted to introduce the physical boundaries of the present study. For much of the period of present concern the influence of the Viking Age and Late Norse earls of Orkney extended from the River Oykel on the Scottish mainland to Shetland, c.400km to the north. This area encompassed a diversity of physiographic regions, ranging from relatively rich agricultural zones (in Orkney, the Caithness Plain, the Moray Firth Lowlands, the river valleys of Sutherland and small parts of Shetland) to extensive upland peat lands of use principally for rough grazing (in central and western Sutherland and much of Shetland). The agricultural potential of all these areas was probably affected by climatic changes associated with a putative 'Medieval Warm Period' and 'Little Ice Age'. However, local variability in the chronology, intensity and continuity of these phenomena is too great for precise modeling of economic impacts to be a realistic goal. Orkney, Shetland and the Caithness Plain were largely cleared of trees long before the Viking Age. Nevertheless, localised scrub woodland survived and substantial forest remained in parts of Sutherland.

Domestic animals - cattle, sheep, pigs, horses, dogs and cats - were the principal terrestrial mammals of Orkney and Shetland. The diversity of wild fauna was greater on the Scottish mainland, with major differences including the presence of carnivores such as wolves and foxes. Inhabitants of both the islands and the mainland coast also had access to extremely rich fish stocks, whale stocks, seal pupping and basking grounds, sea bird colonies and marine mollusc populations. While stocks of fish such as cod can be susceptible to climatic deterioration there is little evidence to suggest that they were significantly affected during the centuries of present concern.

Chapter 3

Sources for the Study of Viking Age and Late Norse Orkney, Caithness and Shetland

3.1 Introduction

There are essentially four sources of evidence currently available to a student of Viking Age and Late Norse economy in Scotland. Although the periods are largely protohistoric, contemporary or nearly contemporary historical sources do exist - particularly for the 12th century and later. In addition to this evidence, medieval records from other regions of Scandinavia and Scottish accounts from subsequent periods can provide useful analogies for the interpretation of issues or centuries poorly served by a direct historical record. Extant and recorded place names of Norse origin also reveal much regarding the character of settlement and economy in northern Scotland and the Isles. Finally, archaeological evidence (including artifacts, structures and ecofacts) provides the primary bases for palaeoeconomic reconstruction.

Each of these sources represents a body of scholarship characterised by methodological and hermeneutic debate. It is impractical to review the development and complexity of all historical, ethnohistoric, onomastic and archaeological inquiry regarding the whole of Scandinavian Scotland. It is useful, however, to briefly introduce strengths and weaknesses of the primary material used by each discipline, particularly as it bears upon the subject of this thesis.

3.2 Historical Sources

Viking and Late Norse studies are inevitably framed by the flamboyant and detailed literary record of the 12th to 14th century Icelandic saga tradition. Saga evidence has provided the ultimate basis for much modern historical writing regarding both Viking Age and Late Norse Orkney, Caithness and Shetland (e.g. Clouston 1932:18-214; Crawford 1987:51-80; Thompson 1987:12-23, 34-78). However, the evidence for these periods is not of equal quality. While several sagas present 'historical' descriptions of events which are alleged to have taken place in Viking Age (pre c.1050) Scotland, their portrayals of economic and social organisation probably pertain more closely to the 12th-14th century contexts in which their authors lived (see Crawford 1987:9; Foote 1988:194; Miller 1990:44-45). Despite this problem, sagas are often the only historical sources for earlier centuries and must sometimes be used (with caution) to enhance interpretation of *both* Viking and Late Norse society in Scotland.

Eight sagas are of vital importance for the present study. Primary among these is *Orkneyinga Saga*, also known as *Jarls' Saga* (Taylor 1938:21-23). The bulk of this account was probably written in Iceland within a few decades of 1200 A.D. (Guðmundsson 1993). The work demonstrates considerable familiarity with local geography and partisan sympathy for several of its 12th century protagonists. It has been suggested that the author had family connections in the earldoms, and thus access to accurate local knowledge (see Taylor 1938:26-33; 103-109; Guðmundsson 1993).

Orkneyinga Saga represents the synthesis of many pre-existing sources regarding an immense chronological span - from the mythological discovery of Norway to the death of the magnate Sveinn Ásleifarson c.1171 (Taylor 1938:16-20; 341-342). Its focus, however, is on the 12th century. This original compilation was updated, perhaps on several occasions, expanding the saga's coverage into the first two decades of the 13th century (Guðmundsson 1965:289-300; Taylor 1938:88-94).

Modern editions of *Orkneyinga Saga* (e.g Taylor 1938:127) sometimes also incorporate details from the shorter and longer *Magnus' Sagas*, hagiographies of earl Magnús Erlendsson (died c.1117) thought to have been written in northern Iceland (Pálsson & Edwards 1987:45). The shorter *Magnus' Saga* may have been composed c.1250 and both versions were probably ultimately based on a Latin *Vita* written c.1137, possibly by Robert Cricklade (a Canon in Cirencester who is known to have visited Scotland) (Pálsson & Edwards 1987:45). Although largely unhistorical, the incidental detail of these sagas sometimes proves useful to the palaeoeconomist (see Section 6.8.3 below).

The *Magnus' Sagas* and *Orkneyinga Saga* can be treated as nearly contemporary sources for the 12th and early 13th centuries. However, the latter's descriptions of earlier years must be suspect. The same caveat applies to additional details regarding 11th century Orkney in Snorri Sturluson's *Heimskringla* (e.g. Magnusson & Pálsson 1966:141). This history of the kings of Norway is too well known to require substantial introduction. It is thought to have been composed in Iceland during the 1220s or 1230s (Bagge 1991:1).

Details allegedly regarding 11th century Orkney also form a significant component of *Njal's Saga*, an anonymous Icelandic composition of c.1280 (Magnusson & Pálsson 1960:9). It has been suggested that this information may ultimately derive from a lost saga of earl Sigurðr Hlǫðvisson (Magnusson & Pálsson 1960:341). Nevertheless, the stories are probably far from contemporary in origin.

Two further Icelandic compositions, *Sverri's Saga* and *Hákon's Saga*, are of greater historical value. These accounts of the Norwegian kings Sverrir Sigurðarson (reign 1177-1202) and Hákonar Hákonarson (reign 1217-1263) record events in the Scottish earldoms which postdate the coverage of *Orkneyinga Saga*. Although partisan (Sverrir commissioned his own saga and Magnús Hákonarson his fathers), they were written during or shortly after the death of their protagonists (Sephton 1899:1; Cowan 1990:105-106). Moreover, one can take some comfort from the tenet of medieval Scandinavian historiography that false recording constituted mockery (see below).

Many other Icelandic sagas mention Orkney, Caithness or Shetland in passing (e.g. *Bandamanna Saga*, Porter 1994:110; *Sturlunga Saga*, McGrew 1970:129-130) or provide analogies which may be of relevance to Scandinavian Scotland. *Færeyinga Saga* (Johnston 1994) is perhaps the best example of the latter possibility. It yields little direct evidence regarding Scotland, but patterns of economic organization in Faeroe might be of some relevance to similar colonies to the south. *Færeyinga Saga* is thought to have been composed in Iceland early in the 13th century (Johnston 1994:7; Foote 1984a:172-173).

Although written in Latin rather than the vernacular, the *Historia Norwegiae* can be discussed in the context of saga literature (from the perspective of date and historical reliability). It is thought to have been composed early in the 13th century, in Orkney or (more probably) Norway (Chesnutt 1985; Crawford 1987:3). Like contemporary sagas, this history of Norway attempts a fanciful reconstruction of the distant past - including the 9th century Norse settlement of northern Scotland (Anderson 1990[1922]:330-331).

Many historians (e.g. Bagge 1991:57-61; Byock 1993:31-50; Cowan 1973; 1982:26; Miller 1990:43-76; Sawyer & Sawyer 1993:21-24) and anthropologists (e.g. Durrenberger 1989:229-232; Ingimundarson 1992:217-218; Turner 1971) have wrestled with the legitimacy of Icelandic sagas as historical and ethnohistorical sources. While the subtleties of this debate are sometimes complex, contemporary scholarship has concluded that at least the less fanciful saga genres are extremely useful sources for the study of medieval Scandinavian society. Even if (or when) saga events are entirely invented, they may convey useful information in two ways. First, details of daily life which are incidental to the dramatic, political or ecclesiastical purpose of a saga are probably valid ingredients for the stew of palaeoeconomic reconstruction (Miller 1990:46). Second, shared (or even contested) cultural perceptions should underlie even narrative which is entirely fictitious (see Foote 1988:194).

As discussed above, however, sagas often present problems of chronology. What *are* 12th-14th century accounts which allegedly refer to the Viking Age? Are they redactions of earlier oral compositions (Foote 1965), expressions of 12th-14th century society (Foote 1988:194; Miller 1990:44-45) or courtly reconstructions of an imagined past (Bruhn 1993:241-242)? The answer is probably a combination of all three possibilities, in significantly varying proportions. It is now widely accepted that 'historical' works such as *Orkneyinga Saga* and *Heimskringla* were authored, not simply committed to writing, in the 13th century (e.g. Bagge 1991:23-63; Taylor 1938:18-20; see also Magnusson & Pálsson 1960:26). However, the historical intent expressed in Snorri Sturluson's preface to *Heimskringla* should probably not be completely dismissed:

> In this book I have had old stories written down as I have heard them told by intelligent people, concerning chiefs who have held dominion in the northern countries, and who spoke the Danish tongue; and also concerning some of their family branches, according to what has been told me. Some of this is found in ancient family registers, in which the pedigrees of kings and other personages of high birth are reckoned up, and part is written down after old songs and ballads which our forefathers had for their amusement. Now, although we cannot just say what truth there may be in these, yet we have the certainty that old and wise men held them to be true...
>
> There were skalds in Harald's [Haraldr inn Hárfagri] court whose poems the people know by heart even at the present day, together with all the songs about the kings who have ruled in Norway since his time; and we rest the foundations of our story principally upon the songs which were sung in the presence of the chiefs themselves or of their sons, and take all to be true that is found in such poems about their feats and battles: for although it be the fashion with skalds to praise most those in whose presence they were standing, yet no one would dare to relate to a chief what he, and all those who heard it, knew to be a false and imaginary, not a true account of his deeds; because that would be mockery, not praise. (Laing 1889:262-265)

In the discussions to follow, sagas are used with some confidence for the interpretation of 12th and 13th century events. Accounts allegedly referring to earlier centuries are more often used to illuminate the period in which they were written than the times they purport to describe. Saga evidence is accepted, however, as the only source which provides a broad outline of political history and dynastic succession for Viking Age Norway and its North Atlantic colonies.

Scottish and northern English chronicles such as John of Fordun's *Chronicle of the Scottish Nation* (Skene 1993[1872]), Roger of Hoveden's *Chronica* (Stubbs 1871) and the *Chronicle of Melrose* (Stevenson 1991) are in some ways analogous to the Scandinavian sagas. Substantial portions of these narrative accounts were compiled centuries after the events they purport to describe and are thus of questionable credibility. They are not, however, homogenous in their unreliability. The later portions of both the *Chronicle of Melrose* (1136 to 1264) and Hoveden's *Chronica* (1192-1201) are thought to be contemporary accounts (Llanerch Press 1991:5; Stubbs 1871:vii). Fordun's chronicle, compiled in the mid 14th century, may be less reliable regarding many of the centuries of interest in this study (Skene 1993[1872]:lxxviii). Despite their limitations, these sources contain details which can corroborate and supplement saga evidence.

The saga and chronicle traditions provide the most comprehensive written sources for a study of Scandinavian Scotland. Nevertheless, other historical data are also extremely valuable. Some Scottish events, even regarding the otherwise poorly documented Viking Age, are recorded in Irish monastic accounts such as the *Annals of Ulster* (MacAirt & MacNiocaill 1983). Although brief, and written far from our area of concern, these records have two important advantages over most other sources: they are contemporary and were intended to record "remarkable occurrences" rather than to entertain (Smyth 1972:1-2). Similar advantages pertain to the Icelandic Annals (Storm 1888). Although they are probably not contemporary until the 12th century (Beckman 1912), these records also reveal events of relevance to Scandinavian Scotland - such as the impact of plague in 1349 (Power 1990:21; Storm 1888: 224, 275, 404).

Several early accounts from more distant sources are also of value, either because they mention Scotland directly or they provide useful analogies. The earliest is perhaps the 9th century account of Ohthere, the Norwegian chieftain who visited the court of King Alfred in Wessex (Lund 1984). Although this record does not mention Scotland, it provides a rare insight into the dynamics of Viking Age economy. A later example is Adam of Bremen's *History of the Archbishops of Hamburg-Bremen* (written c.1070) which refers to the secular and ecclesiastical centre of Birsay, Orkney (Tschan 1959:xv-xvi, 216).

The Norse law books of Orkney and Shetland have disappeared (Barclay 1967:xii; Thomson 1987:156, 160). It can be hoped, however, that Norwegian and Icelandic laws dating from the 11th-14th centuries provide a general (if somewhat idealised) picture of social and economic relations in medieval Norse society. Five codes are particularly valuable. Norwegian laws of the Gulaþing (southwest Norway) and Frostuþing (Trøndelag) districts survive largely intact, incorporating information from the 11th to 13th centuries (Larson 1935:26-27). Subsequently, the universal Landslǫg of Magnús Hákonarson (r.1263-1280) was introduced throughout Norway and its North Atlantic colonies (Keyser & Munch 1848; Robberstad 1983:50-58). An addendum to this code explicitly written for Faeroe (in 1298) survives as the *Syða Brævið* (sheep letter) (Poulsen & Zachariasen 1971; Robberstad 1983:52). It is perhaps reasonable to suppose that similar laws applied to Shetland, Orkney and Caithness. The earliest Icelandic law book, *Grágás*, is a compilation incorporating information from the 11th to 13th centuries (Dennis et al. 1980:4-6). As an independent island colony, Iceland may occasionally provide appropriate analogies for the earldoms of Orkney and Caithness (see Section 3.3 below).

Although the medieval laws of Scandinavian Scotland do not survive, court books are extant from the early 17th century. The earliest example, regarding the years 1602-1604, comes from Shetland (Donaldson 1954). However, the court books for 1614-1615 regarding both Orkney and Shetland may be of greatest value to the present study. After alleged manipulation by earl Patrick Stewart, the Norse laws of Orkney and Shetland were abolished in favour of Scottish practice in 1611 (Donaldson 1974:177-178). To temper this change to local tradition a series of "Country Acts" were passed in 1615 (Barclay 1967:xxvi). These records may thus embody an element of previous practice.

Some legal records regarding Orkney, Caithness and Shetland have survived from the Late Norse Period. These include a miscellaneous assortment of court decrees and land transfer or title documents predominantly from the 14th and 15th centuries (see Clouston 1914; Johnston & Johnston 1907-1913; Johnston & Johnston 1909-1928). Later (16th and 17th century) charters were often sasines, feudal documents recording rights of land holding (Johnston & Johnston 1907-1913; Johnston & Johnston 1907-1942; Johnston & Johnston 1908-1942). Their introduction is concurrent with the waxing of Scottish influence and law in the previously Norse colonies (see Thomson 1987:188-189).

Evidence regarding land holding, and associated tributary payments such as rent, tax and tithe, is also available from a few relatively early sources. A now well known dispute regarding rent from Papa Stour, Shetland, was recorded in 1299 (Johnston & Johnston 1907-1913:38-40; Crawford 1985a:129). A record of payments made by vacant benefices of the diocese of Orkney survives from 1327-1328 (Cowan 1971:8, 11). There is also some extant information regarding the value of tithes owed to the Archbishop of Nidaros by the Bishop of Orkney for the six years prior to 1327 (Anderson 1981[1873]:lxxvii; Gunnes & Kjellberg 1979:201-202; Keller 1991:138). Evidence regarding early tributary payments from Caithness is also ecclesiastical in character. It includes a letter from Pope Innocent III (in 1198) regarding the collection of 'Peter's Pence' (Crawford 1974:17; Johnston & Johnston 1907-1913:22-23), a discussion of tithes (c. 1222) in an addition to Orkneyinga Saga (Guðmundsson 1965:298-300), the 13th century constitution of Dornoch Cathedral (Bannatyne Club

1855:17-21) and an account of crusade contributions from several churches in 1274 and 1275 (Anderson 1981[1873]:lxxxiv; Theiner 1864:112, 115).

More comprehensive rental documents survive from the 15th and 16th centuries. The earliest examples regarding Orkney are Lord Henry Sinclair's rentals of 1492 and 1500 (Thomson 1984:125; 1987:116). Only the latter has been published in full (Peterkin 1820), but data from both rentals are discussed by Thomson (1984; 1987:116-124; see also Anderson 1992:153). A small rental regarding the Bishop of Orkney's lands in Caithness also survives from c.1500 (Andersen 1989:21-22). Early Shetlandic evidence includes two 15th century documents regarding rents owed to the monastery of Munkeliv, Norway (Lange & Unger 1849-1919:Volume xii 123-124, 163; B. Smith pers comm), an inaccurate mid-16th century copy of a rental from c.1500 and an account from 1588 (Goudie 1904:171-185; MacGregor 1984:7; McNeill 1901:325-327).

Finally, much historical evidence is available from miscellaneous sources such as royal, papal and episcopal correspondence (e.g. Clouston 1914:3-8; Donaldson 1974:37-43; Johnston & Johnston 1907-1913:24-25), treaties (e.g. Donaldson 1974:34-36, 85-87) the *Exchequer Rolls of Scotland* (Burnett 1878; 1880; Stuart & Burnett 1878), and English customs accounts (Nedkvitne 1976). These records provide contemporary evidence regarding issues as diverse as export products and penance for specific crimes. However, the volume of information in any one category does not justify lengthy discussion.

Although far from comprehensive, this brief summary introduces the primary historical sources used in the study to follow. A more thorough review of the early sources is provided in Barbara Crawford's *Scandinavian Scotland* (1987:2-4, 7-9). Later works are considered (implicitly) in William Thomson's *History of Orkney*, in Peter Anderson's biographies of earls Robert and Patrick Stewart (1982; 1992) and in Barbara Crawford's essays on medieval (Late Norse) Caithness (1982; 1985b; 1993).

3.3 Ethnohistoric analogy

Like most archaeological inquiry (Wylie 1985), the study of Viking and Late Norse Orkney, Caithness and Shetland is heavily dependent on analogical reasoning. The use of analogy in the present study takes three forms. First, as the preceding discussion has revealed, much historical evidence used to interpret Viking and (to a lesser extent) later medieval settlements of the North Atlantic was committed to writing several centuries after the fact. Twelfth to fourteenth century sources are used as analogs for earlier periods. Second, surviving records (such as law codes) regarding Norway, Iceland and Faeroe may provide useful analogs for Scandinavian Scotland where similar documents have generally not survived. Third, post-medieval records from Orkney, Caithness and Shetland may reveal economic practices of considerable antiquity.

The potential usefulness of relatively late historical sources such as sagas has already been discussed. However, some archaeological studies of recent decades have explicitly criticised or abandoned this late historical evidence (Friðriksson 1994:184-190; see also Champion 1990:91-93). The resulting vacuum has been filled in three ways. First, the use of (for example) saga evidence has simply become implicit rather than explicit - influencing archaeological interpretations much as it had in the past (see Friðriksson 1994:186-190). Second, many archaeologists have turned to cross-cultural ethnographic comparison and (specifically) the models of substantivist economic anthropology to provide analogies for palaeoeconomic reconstruction. The best known exponent of this approach in the English language literature is Richard Hodges (1989a), but he is not alone (e.g. Callmer 1977:179; Hårdh 1978; Kruse 1993:199-200; Thurborg 1988). Third, palaeoeconomists have used (sometimes purely) archaeological evidence to recognize patterns such as the long range movement of products (e.g. Crosby & Mitchel, 1987), weight standards in silver bullion (e.g. Warner 1976) and status associations in faunal remains (e.g. Amorosi et al. 1992).

Each of these alternatives poses its own problems. As Adolf Friðriksson (1994) has illustrated, the first alternative is impractical. Saga and other late evidence must be explicitly addressed, or completely excised, if archaeological reconstructions of the past are to be anything other than unconscious reiterations of 13th century narratives.

The second option, cross-cultural analogy, is potentially useful but prone to abuse. Two opposing schools can be recognized in the interpretation of what Hodges has coined *Dark Age Economics*. Some scholars assume (often implicitly) that trade in the Viking Age was little different, if possibly smaller in scale, than activities known from later medieval historical sources. Key concepts such as market exchange and the profit motive are accepted without question (e.g. Crawford 1987:128-136; Wallace 1987; Wilson 1976:110-111; 1982). If unjustified, these assumptions would be suspect. As discussed in Chapter 6, however, there is considerable archaeological and historical evidence for some market exchange in both Viking Age and Late Norse Scotland (see Section 6.8).

Conversely, others have assumed that generalized models of non market, substantivist, economics drawn from a wide variety of cultures provide the best analogies for northwestern European trade prior to written history. It could be argued that the introduction of writing is indicative of profound changes in social organization (see Austin 1990:29-30). Nevertheless, it seems unreasonable to assume that models ultimately based on phenomena such as the Kula Ring of the Trobriand Islanders are more suitable for the interpretation of Viking Age and Late Norse patterns than historical sources written in Scandinavia itself (Sawyer 1989284). This issue is not necessarily a philosophical contrast between formalist and substantivist economics as Hodges once implied (1989a:13-14; see also Þorláksson 1992). It is simply a pragmatic question of appropriate and inappropriate analogs.

The third alternative, to focus exclusively on the recognition of archaeological patterns, is extremely useful. Ultimately, however, pattern recognition alone is sometimes unsatisfactory. Susan Kruse's (1993) recent study of Viking Age silver ingots and arm-rings from northern Scotland provides an excellent example. The weight distribution of the arm-rings is broadly polymodal, possibly indicating the existence of approximate weight standards. While these data are suggestive in their own right, Kruse (1993:199-200) finds it necessary to appeal to analogies from economic anthropology in order to interpret her results (see Section 6.8.2).

Records regarding Norway, Iceland and Faeroe are of variable utility for the interpretation of Scandinavian Scotland. The considerable legal and social differences between Norway and Iceland illustrate that assumptions of homogeneity in the North Atlantic region should not be made lightly (compare Dennis et al. 1980; Larson 1935). Nevertheless, comparisons do provide working hypotheses in contexts where little or no direct historical evidence is available. In some instances, these hypotheses can then be tested against the patchy archaeological and historical evidence of Scandinavian Scotland. In others, they must remain speculative.

Similar caveats apply to the use of postmedieval records from Scotland to interpret earlier economic activities (Bigelow 1984:15-20). It is important to accept that, contrary to what is sometimes suggested (e.g. Clark 1951:55; see Wylie 1985:70), change through time is common in rural peripheries as well as urban centres. It is inappropriate, for example, to suggest that cured fish were not exported from Caithness and Orkney in the 12th-13th centuries because they were not exported in the 1700s (see Jones 1991a:312-319, 340; Section 1.3.4 above). Substantial changes in local fishing patterns, caused by a shift to large scale kelp production for English glass and soap manufacturers, were recorded during the same century (Fenton 1978:595). Conversely, it may be more reasonable to assume that methods of fish curing used in the 14th-16th centuries resembled those employed in the preceding two or three hundred years (see Chapter 8).

3.4 Onomastic Evidence

Scandinavian place-names, extant and recorded in early cartographic and documentary sources, also reveal information of potential value to the palaeoeconomist. First, they provide some indication of the extent and location of Norse settlement (e.g. Nicolaisen 1976:92; Taylor 1992:143). Second, some name elements have been interpreted in specific economic terms. For example, *sætr* and *ærgi* have been interpreted as shieling (seasonal pastoral settlement) names (Fellows-Jensen 1984:160-163). Third, some scholars have attempted to use place-names to construct models of settlement organization and expansion (Nicolaisen 1976:85-98; Marwick 1952:227-251; see also Wainwright 1962b:120-126).

Onomastic evidence is not, however, without its own complexities. The Scottish Norse dialect, Norn, continued until perhaps the 15th or 16th century in Caithness (Thorsen 1954:233; Waugh 1986:99) and until the 18th century in Orkney and Shetland (Fenton 1978:617). Moreover, many Norse loan words continue in use today in the local dialects of northern Scotland (Waugh 1986:99). The earliest use of many place-names is thus difficult to date. Even if a name was recorded in the 13th or 14th century, it could perhaps have been coined at any time in the preceding four or five hundred years (Fellows-Jensen 1984:148). This problem presents obvious difficulties when trying to reconstruct chronological patterns such as settlement expansion or the character of land use in a specific period. An associated problem is the possibility that the original meaning of names is often lost. Shielings, for example, can become permanent farms without a change of name (see Fellows-Jensen 1984:161).

This investigation will rely heavily on the onomastic surveys of five previous workers. Hugh Marwick's classic studies (1952; 1970) provide a systematic record of the Orcadian evidence and establish models of settlement expansion which still have currency today (e.g. Nicolaisen 1976:85; Thomson 1987:25-26). William Nicolaisen (1976; 1982) has been responsible for the most comprehensive study of Scottish place-names. He has suggested chronological trends in name giving which (although not undisputed) are of relevance to any discussion of early Norse settlement. Gillian Fellows-Jensen (1984; see also 1987) provides an insightful reassessment of Nicolaisen's conclusions. More recently, Doreen Waugh (1984; 1985; 1986; 1993) and Ian Fraser (1979; 1986) have conducted detailed studies of the Scandinavian place names of Caithness and Sutherland respectively.

3.5 Archaeological Evidence

3.5.1 Introduction

Archaeological evidence regarding Norse settlement in Orkney, Caithness and Shetland falls into three categories. First, approximately 40 'sites' (31 settlement and/or ecclesiastical sites and 9 cemeteries or single graves) have been the foci of modern excavation campaigns leading to at least preliminary reports. Twenty of these projects also entailed collection and at least cursory analysis of ecofacts of palaeoeconomic relevance (such as animal bone and/or carbonised vegetation). These 20 'sites' can be subdivided into 28 distinct faunal and 24 separate botanical assemblages (see Tables 5.1-5.2 and Appendix 5.1) Second, a substantial number of structures, hoards, burials and single finds have been recorded during antiquarian excavation and accidental discovery. Third, a number of structures of Late Norse date are still upstanding and have been the subject of architectural surveys. Appendices 3.1, 3.2 and 3.3 represent attempts to tabulate the most important excavations, structures and graves respectively. Note, however, that buildings which have been the foci of excavation are listed in Appendix 3.1 rather than 3.2 (with the exception of antiquarian 'clearing' projects lacking attention to artifactual and ecofactual evidence). In total, this study will consider 98 'sites', finds and buildings of probable Viking Age or Late Norse date.

Appendices 3.1-3.3 are intended as a guide to sites frequently mentioned in the thesis, not as comprehensive corpora. In particular, upstanding structures have only been included if specifically mentioned in the discussions to follow. This category of evidence is masterfully surveyed in Gifford's (1992) *The Buildings of Scotland: Highlands and Islands* (see also MacGibbon & Ross 1990 [1887-1892]; MacGibbon & Ross 1991 [1896-1897]). More comprehensive catalogues of archaeological finds from Orkney, Caithness and Shetland are also available. The reader is referred to publications of the Royal Commission on the Ancient and Historical Monuments of Scotland (e.g. RCAMS 1911a; 1911b; 1946a; 1946b; Lamb 1980b; 1982; 1983a; 1984; 1987; 1989), to Grieg's (1940) *Viking Antiquities in Scotland* and to Graham-Campbell's (1976; 1993; 1995) surveys of the hoard evidence (note that Graham-Campbell's [1995] corpus of Scottish Viking Age silver and gold was published after much of the present thesis was written). Recent syntheses of archaeological evidence from Orkney and Caithness are provided by Morris (1985; 1992) and Batey (1987b; 1991a; 1991b; 1993b) respectively.

3.5.2 Some Problems of Interpretation

Although substantial, the archaeological evidence presents some problems of interpretation. First, only 19 of 40 modern excavations have reached final (or forthcoming) publication. The available information regarding many sites is incomplete and, in some cases, rather conjectural in nature. A corollary of this problem is that the dating of many sites and finds is less than secure. Obvious uncertainties are discussed below, but it has been necessary to accept poorly substantiated dates in some preliminary reports. A second problem regards the comparison of different categories of finds. In many cases, not all artifactual or ecofactual materials have been analysed. At Quoygrew, Westray, Orkney, for example, only the fish bone assemblage has been analysed (Colley 1983a:208-217). This common pattern presents obvious problems of comparison.

A more conceptual problem regards the definition and meaningful comparison of archaeological 'sites'. The entries in Appendices 3.1 and 3.2 range from excavations of a single grave or hoard (the Skaill hoard, Orkney, for example) to extensive studies of settlement 'landscapes'. At Freswick Links, for example, 14 excavation areas were investigated along over 200m of eroding coastline (Morris et al forthcoming a). This problem becomes particularly acute when multiple excavation reports exist for a single settlement landscape. Three final reports are currently published regarding excavations of Norse deposits at the Brough of Birsay, a small tidal island in Orkney (Curle 1982; Hunter 1986; Hunter & Morris 1982; see also Brady & Morris 1995). A fourth is forthcoming with some preliminary results now available (Hunter & Morris 1981; Morris pers comm.).

It may be useful to dissolve the archaeological term 'site' into two concepts - the *deposit* and the *landscape*. An archaeological deposit can be defined as an accumulation of sediment created by a single past activity, by repetition of a single activity or by a combination of related activities. An archaeological landscape is the distribution of these deposits in space. Perceived concentrations of deposits create the phenomena usually described as sites.

These definitions represent a simplification of long-standing ideas regarding inter-site and intra-site variability in the archaeological record - ideas which have been embraced by a number of workers using a plethora of labels. At a landscape level, these include 'distributional archaeology' (see Dunnell & Dancey 1983:271-274; Ebert 1992; Wobst 1983) and 'off-site archaeology' (see Bintliff & Snodgrass 1988; Foley 1981; McNiven 1992). Moreover, concepts of intra-site patterning such as 'activity area' (e.g. Carr 1984:113-133; Kent 1984) and 'taphonomic group' (Gautier 1987; see also Dennel 1972;1976; Hillman 1984 for similar concepts applied to archaeobotanical assemblages) are examples of the same overarching principle.

Accepting the above conception of archaeological remains, researchers typically pursue two ideal options. One is to conduct analyses at the deposit level, dividing each site functionally as well as chronologically. It may then be possible to isolate chronological and social trends without fear that one is simply recognizing differences between (for example) household rubbish and primary fish processing waste. This approach has been successfully applied to Norse deposits from Freswick Links (Morris et al forthcoming d; Rackham forthcoming) and is built upon in Chapter 7 below. In many cases, however, arbitrary archaeological 'sites' are used as a basic unit of analysis. Data from diverse deposits are combined in many reports, or must be aggregated to yield useful sample sizes.

The second ideal option is to isolate a meaningful unit of economic production (or waste disposal) and to pool evidence from recognizable deposits within it (see McGovern forthcoming). Alan Small (1968:6) has suggested that the farmstead, "a self-supporting unit drawing on all resources of the environment," was the primary socioeconomic unit of the Viking Age. In his view, it must have encompassed a dwelling, outbuildings, arable fields (close to the settlement), pasture land (further afield), peat deposits (for fuel and building material) and access to the sea (Small 1968:6-10; 1969:149). It must be accepted, however, that evidence regarding settlement patterns is limited regarding the 9th and 10th centuries. Small's interpretation, for example, was based primarily on two sites (Underhoull and Jarlshof), one of which may not actually date to the Viking Age (Bigelow 1987:25).

In addition to this model of isolated farmsteads (which may well have existed), historical evidence suggests that large estates were probably also common at least by the Late Norse Period (Thomson 1993). *Orkneyinga Saga*, for example, implies the existence of large estates and estate managers by the 11th or 12th century (e.g. Pálsson & Edwards 1981:41, 88, 101, 124, 128, 143, 150-151, 185, 208). It also mentions tenants (Pálsson & Edwards 1981:163, 197), who are known in Norway from 12th-13th century law codes (Larson 1935:89-107, 377-390). Later documentary evidence is similarly revealing. In 1313 Erling Vidkunnson, the most powerful aristocrat in Norway, married a heiress with estates in Orkney (Urbanczyk 1992:47). Moreover, the 1492 and 1500 rentals for Orkney reveal that approximately 336 pennylands (a unit of land assessment) pertained to the earldom, 673 to the crown and 1341 to independent secular ('odal') land holders (Anderson 1992:153; Thomson 1984:137). Thus, estates held by king and earl amounted to over 40% of the land in secular control within a century of the end of the Late Norse Period. Another 1000 or more pennylands were in control of the Bishopric of Orkney (Anderson 1992:153). The settlement pattern of these estates remains uncertain and is perhaps likely to have been variable (see Thorsteinsson 1981 for a Faeroese example). However, one might expect them to have encompassed diverse activity areas - ranging from upland shielings (seasonal pastoral settlements; see Mahler 1991 and Sveinbjarnardóttir 1991 for useful analogies from Faeroe and Iceland) to coastal fish processing locations (see Section 7.2 below).

The archaeological identification and investigation of an entire Late Norse estate has not yet been attempted. However, intra-settlement patterning can be studied in a limited way at Freswick Links and Robert's Haven where spatially and functionally distinct (but broadly contemporary) deposits have been examined independently. Moreover, by comparing and contrasting different 'sites' (many of which presumably represent elements of separate estates) it may be possible to identify some of the economic foci which might have existed in such a hypothetical entity (see Chapter 7). At a more general level of analysis, it may be possible to identify the primary economic activities of the earldoms by considering the available palaeoeconomic evidence as a whole, aggregated at the rather arbitrary site level. While this approach lacks resolution, it should facilitate recognition of the broad categories of production which formed the primary sources of wealth in Norse Orkney, Caithness and Shetland. Chapter 5 attempts such an overview, providing synthetic accounts of arable agriculture, pastoralism, fishing, fowling, hunting and collecting.

Putting this conceptual issue aside, the archaeological data also present specific technical problems. For example, palaeoeconomic data such as faunal assemblages have been recovered and analysed using widely divergent procedures (see Table 5.1). These differences occur between sites and even between different classes of bone (mammal, bird and fish) within single assemblages. There is little need to emphasise the well known impact of different recovery procedures on the results of ecofactual analyses (e.g. Jones 1982; Payne 1972;1975; 1992; Stewart 1991; see Section 5.2.2 below). However, variability in analytical procedures is similarly important. For example, Rowley-Conwy's (1983) report on mammal and bird bone from Saevar Howe excluded specimens not identified to genus or species. This omission makes it difficult to compare the relative abundance of mammal, fish and bird bone at the level of class (see Section 5.6 below). Other examples include differences in the number of fish bones routinely identified to family, genus or species by different analysts. Jones (1991a:55), for example, consistently identified only four Gadidae elements in his analysis of the Freswick Links assemblage. Biases introduced by all of these factors are addressed in Chapters 5 and 7.

Norse graves from the earldoms also raise practical concerns. Many Viking Age burials were recovered and published prior to the development of modern techniques of excavation and analysis. Data regarding the sex of the interred, what grave-goods were included and even the identification of specific materials (jet, for example [see Grieg 1940:24, 86, 87; Davis & Sheridon 1993]) are therefore open to question. Table 3.1 provides some indication of the quality of the available data.

Furthermore, many Norse grave-goods have not been subjected to rigorous typological dating since the first half of the 20th century. The dating of all but recently discovered objects derives predominately from classic studies by Brøgger (1929; 1930) and Shetelig (1945). For the present their results must be accepted as broad guidelines. As Thorsteinsson (1968:164) observed some years ago, however, a new analysis of these graves is perhaps "one of the most important tasks to be found in Viking Archaeology in Scotland." Recent reassessment of several artifacts by Bjørn Myhre (1993) is an important, but not yet decisive, step in this direction.

Radiocarbon dates, available for some recently excavated skeletons (examples include burials from Upper Scalloway, Brough of Deerness, Brough Road Areas 1 and 2, Graemsay, John O' Groats and Murkle; see Appendix 3.3) may also be problematic. Section 5.6 below establishes the importance of marine resources, principally fish, in the Viking Age and Late Norse diet. The ^{14}C deficiency in ocean water may thus make the dates of burials inappropriately old (Harkness 1981). Once again, this issue requires future investigation. For the present study, available radiocarbon assays are accepted insofar as they reveal broad patterns. They are seldom used, however, as concrete evidence for the date of specific burials.

Despite these problems, archaeological evidence regarding the Norse occupation of Orkney, Caithness and Shetland is among the richest for any period in the pre- and protohistory of Scotland. It compares less favourably with contexts such as Iceland and Greenland, where patterns of abandonment have sometimes left ruins undisturbed by subsequent building and agricultural activities (e.g. McGovern 1994; Sveinbjarnardóttir 1992a). Nevertheless, it is a corpus from which it is realistic to attempt meaningful palaeoeconomic interpretation.

3.5.3 The Evidence

Of the 98 sites which this study considers, 52 are in Orkney, 33 are in Caithness (including Sutherland) and 13 are in Shetland. In Orkney, 21 of the 52 sites are settlement s (or settlements also associated with churches), seven are exclusively ecclesiastical in character (within the excavated area), one revealed the 12th-13th century waterfront of Kirkwall, six were hoards and 17 were cemeteries or single graves (Appendices 3.1-3.3).

Four settlement sites date exclusively to the Viking Age (omitting earlier and/or post-Norse phases not of present concern): Brough of Birsay Room 5 (Hunter & Morris 1982), Buckquoy (Ritchie 1976-1977), Brough Road Areas 1 and 2 (Morris 1989) and Saevar Howe (Hedges 1983). Two hoards, Broch of Burgar and Skaill, can also be attributed to the Viking Age (Graham-Campbell 1976:128; 1985:242-244; 1993:184). The remaining four Orcadian hoards, Stenness, Ring of Brodgar, Burray, and Caldale, date to either the end of the Viking Age or the 11th century transition to the Late Norse Period 1 (Graham-Campbell 1976:124, 126, 128-130; 1993:182, 184).

Twelve single graves, two cemeteries and one triple burial also date to the Viking Age. The single burials, which occur on the islands of Mainland (6), Sanday (4), Rousay (1) and an unknown location (1), are tabulated in Appendix 3.3. Nine are poorly recorded, but can be confidently identified as graves. Two finds, at Sties, Sanday (RCAMS 1946a:44), and Howe, Mainland (Grieg 1940:80-81), are represented only by single objects. A third 'grave', the Knowe of Swandro, Rousay (Grieg 1940:88-90; RCAMS 1946a:220; Shetelig 1945:7), includes a sword and shield boss discovered separately and may actually represent two burials. The cemeteries of Westness and Pierowall are incompletely published, but both have been tentatively dated to the 9th century (Kaland 1993:312; Shetelig 1945:6). A triple burial in a boat recently excavated at Scar, Sanday, has also been tentatively dated to this early phase of Norse activity in the islands (although radiocarbon dates are not yet published) (Owen & Dalland 1994:169-170).

A cemetery of Pictish and Viking burials at Brough Road Areas 1 and 2 may extend into the Late Norse Period. While two burials are dated as VA2, a third (an adult of indeterminable sex with no grave-goods) could date to either the end of the Viking Age or early in the Late Norse Period (Morris 1989:114, 120, 123, 127, 137, 141). A radiocarbon assay on the skeleton itself yielded a date of 1040$\pm$60 b.p. - which calibrates to A.D. 880-1140 at the two sigma level (Morris 1989:123).

The chapel and cemetery site at the Brough of Deerness also has both Viking and Late Norse phases. A stone-clad wooden chapel is probably of Viking Age, or possibly Pictish, date (Morris & Emery 1986:356-366). It is associated with two infant graves (Morris & Emery 1986:314, 320, 357-358). The timber chapel was replaced by a stone equivalent associated with four additional burials - one adult, one child and two infants - during the 11th century transition from VA2 to LN1 (Morris & Emery 1986:357).

Six Orcadian settlement sites include both Viking Age and Late Norse phases: Tuquoy (Owen 1993), Pool (Hunter et al. 1993), Brough of Birsay (early excavations; Curle 1982), Brough of Birsay Sites VII-IX (Hunter 1986), Brough of Birsay Areas 1-6 (Morris pers comm.) and Earl's Bu (Batey 1993a). Pool merits attention as one of few sites with a confirmed phase dating to the earliest years of the Viking Age, perhaps the late 8th or early 9th century (Hunter et al. 1993:280-281). The Brough of Birsay sites also require some explanation. Settlement on the Brough appears to have ended in or by the 12th century (e.g. Hunter 1986:142-143). However, five sherds of imported wheel-made pottery indicate some later use (Curle 1982:89-90, 121; Hunter 1986:185).

A further eight settlement sites have only Late Norse phases. They are: St. Boniface (Cerón-Carrasco 1994; Lowe 1990; 1993), Quoygrew (Colley 1983a:208-217), Langskaill (Davidson et al. 1986), Cubbie Roo's Castle (Lamb 1980a:94), The Wirk (Lamb 1993b:53-54), Beachview Burnside Area 2 (Morris forthcoming a), Beachview Studio Site (Morris forthcoming a) and the Bishop's Palace (Simpson 1961). Five ecclesiastical sites are also exclusively Late Norse in date: St. Magnus Church, Egilsay (Fernie 1988), St. Magnus Church, Birsay (Barber forthcoming), St. Olaf's Church, Kirkwall (Lamb 1993a:46), St. Magnus Cathedral (Cambridge 1988; Cruden 1988; Fawcett 1988), and St. Nicholas Chapel, Orphir (Fisher 1993).

Structures and fill associated with the Late Norse (perhaps 12th-13th century) waterfront of Kirkwall have been excavated at Tankerness House (McGavin 1982:399-402). It should also be noted, however, that medieval wheel-made pottery has been recovered as residual material from postmedieval sites elsewhere in the town (MacAskill 1982:407-409).

Dating the four remaining Norse sites of Orkney is somewhat problematic. An investigation of buildings and middens at Westness, Rousay, has been published as preliminary reports, but dating evidence is not yet available (Kaland 1973; 1993). Kaland (1973:91) does imply that the settlement spans the Viking Age and medieval period, the latter of which begins after AD 1050 (i.e. LN) in Scandinavian terminology (*Nordic Archaeological Abstracts* 1990:281). However, there is no definitive discussion of dating evidence. In the absence of detailed artifactual or archaeometric data, I have hesitantly ascribed the settlement at Westness to the Late Norse Period. This decision is based on the presence of pottery at the settlement (Kaland 1973:85, 88). The Viking Age is predominately aceramic in the Northern Isles. It is also possible, however, that the pottery is residual material of pre-Norse date (Kaland pers comm.).

The site of Skaill, Deerness, has yielded undisputed Viking Age evidence. However, possible Late Norse deposits are difficult to interpret. It has been suggested, on the basis of several phases of rebuilding, that settlement which began in the Viking Age (at Site 2) may have lasted into the 1000s or 1100s (Edwards forthcoming:16). Gelling et al. (forthcoming:15-16) have also suggested that structures at Site 1 could represent unbroken continuation of this settlement into later centuries. The first suggestion is difficult to assess in the absence of terminal stylistic or archaeometric dates for Site 2. It is difficult to agree with the second argument. The oldest datable artifact recovered from the deposits in question is a jetton made in the mid to late 15th century (Gelling et al. forthcoming:10). Moreover, the remaining artifactual assemblage is dominated by post-medieval pottery. For the present, I class the Norse phases of Site 2 as Viking Age and omit the late deposits of Site 1 from consideration.

A ruined structure on Castle Holm, Howe, has been interpreted as a castle comparable to other Late Norse examples such as Cubbie Roo's on Wyre (Clouston 1931:33-35; Lamb 1980a:94). Presently, however, onomastic evidence and gross morphology are the only bases of this date.

Excavations of a chapel at Newark Bay also remain unpublished. It is recorded, however, that two English coins of mid-10th century date were recovered beneath the structure (Brothwell 1977:182; Stevenson 1986:340). If these relate to the construction or use of the chapel it is presumably of Viking Age origin. This possibility is particularly interesting in light of uncertainty regarding when Christianity became established in the earldoms. It must be accepted, however, that the coins could relate to activity predating, and unrelated to, the chapel.

Of the 33 sites in Caithness and Sutherland, 10 are settlements, four are churches (including a cathedral), three are hoards and 16 are graves or cemeteries. The latter category presently dominates our evidence for an early Norse presence on the Scottish mainland. Six undisputed single graves, six stray finds possibly from graves and one cemetery are all of certain or probable Viking Age date. The best evidence comes from Reay (a cemetery of three or more graves) and the following single burials: Balnakeil; Castletown; Westerseat; Mill of Watten, Huna and Dunrobin Castle (Batey 1993b:150-158). Stray finds which probably derive from graves are known from Haimar, Dunrobin Shore, Dunrobin (IL209), Ospisdale, Thurso East and Keodale (Batey 1993b). A single hoard, from Kirk o' Banks, may also belong to the Viking Age (although a date in the 11th century VA2-LN1 transition is not unlikely) (Graham-Campbell 1976:128-130; 1993:184).

In contrast with this evidence, only one settlement site in Caithness dates to the Viking Age. It is Freswick Links, which also has more substantial Late Norse deposits (Morris et al. forthcoming b). Archaeological data from Robert's Haven (discussed in detail in Chapters 5 and 8), Freswick Castle (Batey et al. 1984) and the Bishop's Palace (Talbot 1970; 1973a; 1973b) are exclusively Late Norse and post-medieval. Similarly, the primary phases of unexcavated castles at Old Wick (RCAMS 1911b:137-139; Talbot 1974:40), Forse (Gifford 1992:117) and Braal (Gifford 1992:107) probably date to the 12th, 13th or (in the case of Braal) 14th centuries on the basis of historical and architectural evidence. The present tower at Bucholie is probably of 15th century origin, but it may overlie a previous castle known from *Orkneyinga Saga* (Batey 1987b:22; 1991a:32; Lamb 1980a:96). Two further castles, Brough and Borve, have been tentatively ascribed to the Late Norse Period on the basis of gross similarity to examples such as Old Wick (Lamb 1980a:90-96). Ecclesiastical structures, such as St. Peter's Church, Thurso (Slade & Watson 1989), Clow Chapel (Talbot 1977; 1980) and St. Mary's Chapel, Crosskirk (Gifford 1992:115), are also of Late Norse (perhaps 12th-13th century) date. Dornoch Cathedral was built in the 13th century (Gifford 1992:562).

Freswick Links is by far the most thoroughly investigated of these sites. Excavation campaigns in the second quarter of the 20th century (Childe 1943; Curle 1939; 1954) have been followed by surface collection and by a major programme of work between 1980 and 1984 (Batey 1982; Batey 1987a; Batey 1989b; Jones et al. 1983; Morris et al. 1992; Morris et al. forthcoming a; Rackham et al. 1984). This long history of investigation does mean, however, that a number of artifacts from early excavations and surface collection are poorly dated (see Batey 1987a:103-285).

Recent work at Freswick Links has definitively established occupation of the site during the pre-Viking Pictish period and in the last centuries of the Late Norse Period (Morris et al. forthcoming a). A probable Viking Age occupation proved more ephemeral during this investigation, but it can be assumed based on typological analysis of a small number of c.10th century artifacts from earlier investigations of the site (e.g. Batey 1987a:256). Complexities surrounding the dating of material from Freswick Links are considered in more detail in Section 5.3.3 below.

Late Norse burials are also known. One, in the church yard of St. Peter's, Thurso, was covered by a rune inscribed cross-slab (Liestøl 1984:228). It is thought to date to the 12th century (Batey 1993b:157). Two cemeteries, dating to the 11th-12th and 13th-14th centuries, have been excavated at John O' Groats (Driscoll 1990) and Murkle Bay (Batey 1993b:160-161; Fojut 1987:25) respectively. The remaining Late Norse sites of Caithness are two hoards, Braemore and Ladykirk, dated to the early 14th century. The provenance of Braemore, however, is somewhat uncertain. It is based on an ambiguous hand written label (Stewart 1973:138).

The archaeological evidence from Shetland includes five settlement sites, two chapels, one or two hoard(s), three single burials and a cemetery (Appendices 3.1-3.3). Two settlement sites, Jarlshof (Hamilton 1956) and Kebister (Owen & Smith 1988), have yielded both Viking Age and Late Norse deposits. Phases 1 and 2 of Jarlshof had been among the few Viking deposits specifically dated to the early 9th century (Viking Age 1). Recently, however, Patrick Ashmore (1993) has suggested that a date later in the century may be more appropriate (although the evidence for this reinterpretation has not yet been published). The two phases at Kebister are chronologically distinct. A possible timber chapel may date to the Viking Age while Late Norse evidence is confined to mixed deposits including wheel made pottery of 14th century date (Owen & Smith 1988:2, 17). Both phases were incidental to the postmedieval focus of excavations at Kebister and little further information is available.

Two or three Viking Age burials are known from Shetland. The two definite examples are both from Unst, at Clibberswick (Grieg 1940:103-105) and an unknown location (Grieg 1940:103; this grave is identified in Appendix 3.3 as IL313-314, the National Museum of Scotland Catalogue number as given by Grieg). A possible third grave is represented by an axe found in the churchyard of St. Olaf's , Whiteness (Shetelig 1945:4).

The two silver hoards from Shetland, Garthbanks/Quendale (deposited c.1000) and Dunrossness Manse (deposited c.1065) date to the 11th century VA2 - LN1 transition (Graham-Campbell 1976:128; 1993:184). There is a slight possibility, however, that the recorded finds actually derive from a single hoard deposited around the later date (Graham-Campbell 1993:176-177).

Three Shetlandic settlement sites, Sandwick (Bigelow 1984; 1985; 1989), The Biggings (Crawford 1985a; 1991a) and Underhoull (Small 1966) probably date exclusively to the Late Norse Period. The chronology of the latter settlement has been a matter of debate. Small (1966) originally suggested that Underhoull was occupied in the 9th and 10th centuries, but Bigelow (1984:138-141; 1987:25) has convincingly argued for a Late Norse, probably 12th century, date. St. Mary's church, Bressay, can be broadly dated to the Late Norse period (Gifford 1992:470-471; RCAMS 1946a:1) and the unexcavated ruins at Lambhoga Head, Dunrossness, may represent the remains of a Late Norse or postmedieval castle (Lamb 1980a:95-96). Finally, two radiocarbon assays on human bone from the cemetery of Upper Scalloway (from which 25 burials have been recovered) suggest dates in the 14th and 15th centuries (Lorimer n.d.; Sharples pers comm.).

3.7 Chapter Summary

This chapter has attempted to illuminate the breadth, advantages and disadvantages of four sources of evidence vital to a study of the earldoms of Orkney and Caithness: contemporary or nearly contemporary historical records, ethnohistoric analogy, onomastic evidence and archaeological evidence. The limited direct historical evidence primarily relates to the Late Norse Period. It ranges from Icelandic sagas and Scottish chronicles to land transfer documents, tithe records and royal correspondence.

Written history of the Viking Age predominantly survives as 12th-14th century saga literature. These sources may provide an accurate picture of (for example) dynastic succession in earlier centuries. It is likely, however, that any socioeconomic information they contain relates more to the context in which they were composed than to the period they purport to describe.

The current study, like most archaeological inquiry, relies heavily on analogical reasoning. As mentioned, 12th-14th century sagas are cautiously used as analogs for earlier periods. Moreover, law codes from Norway, Iceland and Faeroe are drawn upon in the absence of surviving examples from Scandinavian Scotland. Lastly, post-medieval records from Orkney, Caithness and Shetland themselves are used to interpret the Late Norse Period in contexts where continuity of local tradition seems a reasonable hypothesis.

Onomastic evidence also provides useful socioeconomic information. Place-names of Norse origin reveal settlement patterns and imply the existence of economic units such as shielings. It is difficult, however, to isolate reliable chronological patterns in a landscape of place-names coined over many centuries.

Of the 98 archaeological sites considered in this study, 52 are in Orkney, 33 are in Caithness (including Sutherland) and 13 are in Shetland. In Orkney, 21 sites were settlements (or settlements also associated with churches), seven were exclusively ecclesiastical in character, one revealed the 12th-13th century waterfront of Kirkwall, six were hoards and 17 were cemeteries or single graves. Of the 32 sites in Caithness and Sutherland, 10 were settlements, four were churches, three were hoards and 16 were graves or cemeteries. The Shetlandic evidence includes five settlement sites, two chapels, one or two hoard(s), three single burials and a cemetery. Twenty excavation projects (three from Shetland, 14 from Orkney and three from Caithness) entailed collection and at least cursory analysis of ecofacts (principally animal bone and/or carbonised vegetation). The resulting assemblages are dogged by inter-assemblage variability in recovery and analysis procedures. Nevertheless, they must form the primary basis of any palaeoeconomic study of the Viking Age and Late Norse earldoms.

This chapter was intended to introduce the available evidence and illuminate its potential strengths and weaknesses. Having established this background, it is possible to attempt a reconstruction of the protohistory of the earldoms (Chapter 4) and to investigate the economic processes by which their wealth was created and maintained (Chapters 5-9).

Chapter 4
The Wealth of Viking Age and Late Norse Orkney, Caithness and Shetland: A Protohistorical Backdrop

4.1 Introduction

The chronological framework used in this study has already been outlined in Section 1.2 above. The Viking Age can be divided into a preliminary episode of colonisation and culture contact (VA 1, 8th-late 9th centuries) and a subsequent period in which a formalised earldom was established (VA2, late 9th to 11th centuries). The first division of the Late Norse Period (LN1, 11th-13th centuries) is characterised by the expanding power of semi-autonomous and explicitly Christian earls. It is followed by several hundred years (LN2, 13th-15th centuries) during which the earldoms of Orkney and Caithness shrank in extent and independence in the face of waxing Scottish and Norwegian royal power. Shetland was taken under direct Norwegian control in 1195 (Sephton 1899:156-157), Caithness was ultimately surrendered to the Scottish crown in 1375 (Bannatyne Club 1855:79; see Crawford 1982:72) and Orkney was transferred to Scotland in 1468 (as a pledge for 50 000 florins towards the dowry for Margaret of Denmark's marriage to King James III) (Donaldson 1974:85-87).

The account which follows attempts to achieve two goals. First, it constructs a narrative protohistory of the earldoms intended to provide a chronological and cultural context for the palaeoeconomic investigations to follow. Within this narrative, however, I hope implicitly to establish the considerable wealth of Viking Age and Late Norse Orkney, Caithness and Shetland.

The indicators of wealth are direct and indirect. The former are silver bullion and fine metalwork in the Viking Age and monumental architecture and rentals in the Late Norse Period. The latter includes evidence for the existence of an autonomous local elite, at least until the final years of LN2. Although the precise character of Dark Age European society is an issue of ongoing debate, there is little doubt about one salient characteristic - power depended on the acquisition and control of wealth. That is, elites of Dark Age Europe sustained a military retinue - their practical source of authority - with the fruits of plunder, trade and (particularly in later 'medieval' centuries) taxation of a subject peasantry (Crawford 1991b; Hedeager 1994; Reuter 1985). The existence of an Orcadian aristocracy at least partially independent of Norwegian and Scottish royal authority implies a significant source (or sources) of wealth.

4.2 The Viking Age 1 (8th - late 9th centuries): Early contact and colonisation

It has generally been assumed that Orkney and Shetland were colonised from Norway around the turn of the 9th century AD. (e.g. Bigelow 1985:104; Crawford 1987:39-58; Hamilton 1956:106; Hedges 1983:120; Hunter 1986:69-71; Morris 1985:210; 1989:287; 1991:65; Thomson 1987:17-18; Wainwright 1962b:126; but see also Myhre 1993; Sommerfelt 1958). This is based in part on 12th-13th century traditions from both Icelandic sagas (Pálsson & Edwards 1981:26; Pálsson & Edwards 1989:25) and the *Historia Norwegiae* that the archipelagos served as bases for piratical raids further afield. The latter source, for example, includes the following passage:

> In the days of Harold Fairhair, king of Norway, certain pirates, of the family of the most vigorous prince Ronald, set out with a great fleet, and crossed the Solundic sea; and stripped these races [Picts and Papae] of their ancient settlements, destroyed them wholly, and subdued the islands to themselves. And being there provided with safe winter seats, they went in summer-time working tyranny upon the English and the Scots, sometimes also upon the Irish ... (Anderson 1990[1922]:331).

There is also clear evidence from earlier sources such as the *Anglo-Saxon Chronicle* and Irish annals that Viking raids were occurring in Ireland, Scotland and England in the late 8th and early 9th centuries. It is not inconceivable that these were from staging posts in the Northern Isles. Well known examples include the pillaging of Lindisfarne in 793 (Whitelock et al. 1961:36), Skye in 795 (*Annals of Ulster*, MacAirt & MacNiocaill 1983:251), the Hebrides and Ulster in 798 (*Annals of Innisfallen*, Anderson 1990[1922]:257) and Iona in 802 and 806 (*Annals of Ulster*, MacAirt & MacNiocaill 1983:259, 263).

The earliest archaeological evidence for Pictish - Scandinavian contact (although not necessarily settlement) *may* be the suggestion that artifacts of distinctive Pictish form, high-backed, double-sided and long-handled combs, from Buckquoy, the Brough of Birsay, Saevar Howe, Skaill Deerness and Howe were fabricated from reindeer (*Rangifer tarandus*) antler (Weber 1992; 1993; 1994). Although there has been some uncertainty regarding the identification of antler sources in highly worked material (Rackham pers comm.), the combs could imply a period of trade or gift exchange pre-dating the current archaeological evidence for Scandinavian settlement in Scotland. Reindeer became extinct in Scotland c.8000 BP (Clutton-Brock & MacGregor 1988:32). It is also possible that the antler artifacts belong to a period of interaction between native and newcomer in the earliest phases of colonisation. Artifacts from Buckquoy (Ritchie 1976-1977), the Brough of Birsay (Curle 1982) and Skaill (Buteux forthcoming) cannot be closely dated, but double-sided and long-handled combs from Howe were found in 7th-8th century contexts (Weber 1994:192).

Recent archaeological evidence does confirm that Orkney was probably colonised by the turn of the 9th century. Radiocarbon dates from eroding Norse deposits at Pool could even be consistent with 8th century settlement. It is of particular interest that this site exhibited a cultural interface phase characterised by the contemporary deposition of both Norse and Iron Age (Pictish) artifacts (Hunter et al. 1993:280-281; see below).

Ninth century Norse settlement is also suggested by a cemetery at Westness, Rousay, where two pagan boat burials, five pagan oval graves and a number of rectangular burials without grave-goods have been excavated (Kaland 1973:91-97, 100; 1980; 1993:312-317). The interred showed evidence of life in a violent milieu, including weapons - obviously used in the case of a damaged shield boss - and fatal wounds (Kaland 1993:316). One skeleton had been pierced by 4 arrows. Moreover, a female burial was furnished with a highly decorated silver-gilt pin of probable Irish manufacture which could originally have been derived from plunder (Stevenson 1989).

Other grave goods, however, illustrate more prosaic aspects of Viking economy. These included sickles, spindle whorls, a line sinker and a weaving sword (Kaland 1993:312-317). If the number of burials alone is not sufficient evidence for permanent occupation at Westness, the grave-goods are certainly suggestive of settlers.

A triple burial in a boat at Scar, Sanday, has also been tentatively dated to the 9th century (on the basis of artifact typology) (Owen & Dalland 1994:169-170). In addition to weapons and personal ornaments it too contained agricultural implements consistent with permanent settlement (Owen & Dalland 1994:164-169). The burial of an elderly woman in the grave may also suggest that the Norse colony had been established for some years prior to her death.

Although a minimum of 61 definite or probable Viking Age graves are known from Orkney, Caithness and Shetland (Table 3.1), only Westness and Scar have produced burials dated to the 9th century by modern analysis. Even in these cases the publication of radiocarbon dates is still awaited. Other graves from Orkney and Shetland have been dated to the 9th century by Shetelig (1945) (see Appendix 3.3). A cemetery of at least 16 graves from Pierowall merits particular attention (Shetelig 1945:6; Thorsteinsson 1968:165). However, it is not unreasonable to suggest that a modern reassessment is in order before accepting these conclusions unequivocally.

Burials aside, the earliest archaeological evidence for the Norse colonisation of Shetland is Phase 1 of the Viking farmstead at Jarlshof (Hamilton 1956:129-130). As discussed in Section 3.5 above, it has recently been redated to the mid 9th century by

Patrick Ashmore (1993:12). Here too was evidence for a permanent settlement of farmer- fishers (Hamilton 1956:94).

Norse settlement of the 8th or 9th centuries is still elusive in Caithness and Sutherland - possibly owing to the relative paucity of archaeological inquiry (see Batey 1987b:131). Fifteen definite or probable Viking Age graves are known, but none have been specifically attributed to the 9th century. In fact, the only graves tentatively dated more precisely than the Viking Age as a whole (one from a cemetery of three or more graves at Reay and one from Dunrobin) are attributed to the 10th century (Batey 1993b:152, 155; Shetelig 1945:7-8).

Norse settlement in Caithness does seem likely by this later century. Isolated coastal graves such as one recently recovered at Balnakeil (Batey 1993b:157-158; Powell et al. 1991:46) could derive from incidental burial by sea borne traders or raiders. However, the cemetery at Reay is consistent with permanent occupation. Like at Westness, the recovered grave-goods included a sickle (Batey 1993b:153; see Appendix 3.3). Moreover, evidence of 10th century occupation has been discovered at the settlement site of Freswick Links (Batey 1987a:103-285; Morris et al. forthcoming a).

Given the absence of known 8th or 9th century sites in Caithness and Sutherland it is *possible* that the northern Mainland was settled after Orkney and Shetland - an argument advanced by W.F.H. Nicolaisen on the basis of place name evidence (Nicolaisen 1976:90; but see also Fellows-Jensen 1984:158; Waugh 1986:99-100). The only known Viking Age silver hoard from Caithness, consisting of eight silver armlets of 'ring-money' dating to the 10th or 11th century (Batey 1987a:41; Graham-Campbell 1976:126, 128-130; 1993:184; see Table 6.6), is not inconsistent with this interpretation. It is equally possible, however, that the apparent lacuna is a product of limited excavation work in Caithness (Appendix 3.1) and the imprecise dating of Viking Age graves from Mainland Scotland (Appendix 3.3).

The character of Pictish-Norse interaction in the period of colonisation has been discussed by virtually every scholar who has put ink to paper regarding Scandinavian Scotland (e.g. Clouston 1932:2-3; Crawford 1981; Crawford 1987:39-48; Gelling 1984:38-39; Hedges 1983:120; Hunter et al. 1993; Lamb 1993c; Morris 1991; Myhre 1993; Ritchie 1974; Wainwright 1962a:115-116). It is evident that the native Pictish population was subjugated to some degree, largely based on the virtual absence of pre-Norse place names (Fellows-Jensen 1984:151). It has also been argued, however, that a certain degree of continuity or interaction is apparent from Pre-Norse to Viking settlement (e.g. Curle 1982:110; Hedges 1983:120; Hunter 1986:110-113; Hunter et al

1993; Myhre 1993; Ritchie 1974; 1976-1977:192; see Morris 1991). The evidence for an interface period at Pool (Hunter et al. 1993), and the *possible* implications of Pictish access to reindeer antler (Weber 1992; 1993; 1994) have already been mentioned. Finds from the site of Buckquoy (Ritchie 1974; 1976-1977:192) and the Brough of Birsay (Curle 1982:110) are similarly suggestive. Pictish style artifacts, such as pins and high-backed combs, were found in early Viking contexts.

It is unlikely that these divergent interpretations will be easily resolved. The character of Viking settlement remains an issue of debate even in the Danelaw of England where the historical record is far superior (e.g. Lund 1981). Rediscovery of a 9th century reference to an Orcadian bishop (Foote 1986:176; Omand 1986; Thomson 1986a) has provided support for some Christian, if not necessarily Pictish, continuity into the Viking Age. Nevertheless, it cannot be ignored that 21 of the c.61 Viking graves of Orkney, Caithness and Shetland included weapons (Appendix 3.3). The 12th or 13th century *Historia Norwegiae* also suggests a violent takeover (Anderson 1990[1922]:331; see above). Regrettably, however, the historicity of this account is questionable. It also described the Picts as little people who lived under-ground (see Morris 1991:66).

Despite the complexities of this issue, a synthesis of possibilities and probabilities is not beyond our grasp. In a milieu of Scandinavian colonisation, the Picts might face three possible futures: 1) extermination or emigration, 2) integration or submission as *free* subjects, and 3) enslavement. It is not unreasonable to suggest that the third option, enslavement, is the most likely to leave a residue of material culture (such as the combs and pins of Pool, Buckquoy and the Brough of Birsay) and the observable absence of Pictish place names. This hypothesis is tenable if we can make the reasonable assumption that free land holders, the enslaving Vikings, were in a position to name their conquered territory. It is also possible, however, that the blanket coverage of Norse place-names known from Late Norse and modern sources was a product of several centuries (see Section 3.4 above). It may have little relevance to the earliest phase of culture contact.

4.3 The Viking Age 2 (late 9th - 11th centuries): Consolidation and expansion of an earldom

Although the character of the earliest Norse settlement remains a matter of some debate, it has been widely assumed that the northern Scottish colonies were incorporated into a formal earldom, nominally subject to Norway, late in the 9th century (e.g. Crawford 1987:53-56; Hunter et al. 1993:280-281; Morris 1985:212; Thomson 1987:12-13). The bases of this interpretation are predictably late, including the 12th or 13th century *Historia Norwegiae* (Anderson 1990[1922]:331), the 12th century *Landnámabók* (G. Jones 1986:156) and several 13th century Icelandic sagas (Pálsson & Edwards 1981:26; Pálsson & Edwards 1989:25). Some confidence can be derived from approximate agreement among the sources, but this does not guarantee that they are correct. Two variations of the story are evident. In *Orkneyinga Saga* (Pálsson & Edwards 1981:26) and *Eyrbyggja Saga* (Pálsson & Edwards 1989:25), for example, King Haraldr inn Hárfagri of Norway is said to have established the earldom after a campaign to subdue Norse pirates in the west. He allegedly offered Orkney to Rǫgnvaldr Mærajarl, in compensation for his son who had been killed in the campaign. Rǫgnvaldr subsequently gave the earldom to his brother Sigurðr, and medieval tradition suggests that northern Scotland remained essentially in the same dynasty until the death of Earl Jón Haraldsson in 1230 (Pálsson & Edwards 1981:26; See Thomson 1987:14, 56).

Peter Sawyer (1976), however, has suggested that the 9th century expedition of Haraldr inn Hárfagri was a medieval invention, modeled on the late 11th century campaign of Magnús Berfœttr. Some support for this interpretation may come from the *Historia Norwegiae* (Morris 1985:212). In its account the creation of an earldom in Orkney is attributed to members of Rǫgnvaldr's family, without reference to royal interference (Anderson 1990[1922]:331; see quote above).

Regardless of the precise dynastic arrangements, it seems clear that the Norse colonies of northern Scotland were subject to some degree of elite control in the late 9th and 10th centuries. First, Pictish material culture is no longer found in 10th century and later settlements. Examples include Brough Road Areas 1 and 2 (Batey 1989a), Earl's Bu (Batey 1993ba) and Pool Phase 8 (Hunter pers comm.). Some process (be it genocide or assimilation to a dominant culture) had led to the suppression of native custom. Second, elite settlements such as the Brough of Birsay (Hunter 1986:107, 114-115; Hunter et al. 1993:273; Morris 1985:221; 1990:22) and the Brough of Deerness (Morris & Emery 1986:366; Morris 1990:28) are known. These are characterised by defensible locations and a high density of structures, conceivably to house the clients or retinue of aristocratic leaders. At the Brough of Birsay, the more thoroughly investigated of the two sites, an elite presence is confirmed by the recovery of hacksilver, coins and ingot molds (Curle 1982:84; Hunter 1986:187; Stevenson 1986:340). These sites have also been interpreted as monastic settlements (e.g. Radford 1962:166-169, 180; Lamb 1974:93-96; 1983b:42-44), but characteristics such as the absence of a substantial cemetery at Deerness and the scale of structure 17 at Birsay have led Christopher Morris, John Hunter and their colleagues to question this interpretation (Hunter 1986:115; Hunter et al. 1993:272-273; Morris & Emery 1986:366).

Hoards, such as the find from Skaill, Mainland Orkney, (deposited c. 950) could also be interpreted as evidence for hierarchical social relations. This example, at over 8kg, is the largest known silver hoard from Scotland. It is three times larger than any contemporary hoard from Norway and among the largest hoards known from Scandinavia as a whole (Graham-Campbell 1993:180). The ability to amass such extraordinary wealth in one place certainly suggests the existence of central power. It is also significant that large silver ball-type penannular brooches constitute a significant portion of the hoard (Graham-Campbell 1995:108-127). Brooches, as discussed by Margaret Nieke (1993), were symbols of elite status in Dark Age Britain and Ireland.

It is difficult to suggest, however, whether the power so inferred was unitary or fragmented. The existence of nine substantial Viking Age hoards (Table 6.6) and multiple elite centres may suggest the existence of competing factions. This interpretation is certainly consistent with the medieval historical tradition, in which the earldom was often divided amongst rival claimants (Pálsson & Edwards 1981). It is also possible, however, that centres such as Deerness, Birsay and perhaps Jarlshof in Shetland (where ingot moulds, silver objects and other elite metal work have also been found [Bruce 1907:28; Graham-Campbell 1993:184; Hamilton 1956:128,134,140, 150,152; Stevenson 1986:340]) were the foci of peripatetic earls and their retinues.

It is also difficult to suggest the precise structure of a putative hierarchy. Viking Age graves might be expected to reveal further detail regarding the subtleties of social organization (compare Arnold 1979; Boddington 1987:414; Samson 1987 for alternative perspectives on the value of grave-goods as indicators of status). Regrettably, however, many were discovered and excavated in the last century and serious study of this material would require museum and archive research beyond the scope of the present thesis. Interpretations which can be sustained on the basis of present data are suggestive but often ambiguous.

It is evident, however, that not all burials were equally wealthy. Figure 4.1 illustrates the number of categories of grave-goods represented in each of the 18 Viking Age burials for which complete or nearly complete records are available (categories a and b in Table 3.1 and Appendix 3.3). The number of artifact types recovered ranges from none to 13. This inequality probably entails several different cultural phenomena (see Appendix 3.3 for references regarding the following examples).

Burials without grave-goods are probably the result of age patterns and (in one case) uncertainty regarding dating. Three of the four burials with no grave-goods contained infants or children. A boy of eight to 13 years interred at Balnakeil was buried with a substantial suite of artifacts. However, neonatal or young individuals seem not to have passed a critical cultural threshold. The fourth burial without grave-goods (Brough Road Area 1 No. 1) yielded a radiocarbon assay which spans both VA2 and LN1 (Morris 1989:123). As illustrated in Table 4.1, grave-goods ceased to appear in burials dated to the Late Norse Period. The most straightforward explanation for this change is a shift to Christian practice.

The remaining 14 examples require a different explanation. They range from an adult probable female burial accompanied only by a knife (Brough Road Area 2 No.1) to an adult female grave with 13 grave-good categories (Westness 1). Males and females with from four to 10 artifact types are represented among the intermediate examples.

It has been suggested that differences in the concentration of grave-goods is a chronological pattern indicative of increasing Christian influence (Crawford 1975:16). Although this hypothesis probably has validity in a broad sense - burials dated to LN1 by archaeometry lack grave-goods (see Table 4.1) - it cannot be sustained for the Viking Age as presently defined. As discussed in Section 3.5, few graves are dated with sufficient precision to identify changes from the 800s to 900s. Moreover, at least one example from the latter century has a substantial artifact assemblage (Buckquoy adult).

Although the chronological component of Crawford's argument is problematic, the possibility that graves with fewer associated artifacts are indicative of Christian influence cannot be entirely ruled out. As discussed below, there is suggestive evidence for some Christian presence in the earldoms throughout the Viking Age. It is also possible, however, that differences in the number of grave-goods are indicative of status distinctions (be it of the dead or the living, see Samson [1987:123]).

Given the latter possibility, several aspects of these graves are notable. The extreme difference between burials such as *Brough Road Area 1 No. 1* and *Westness 1* alone may be sufficient to suggest the existence of a social hierarchy. Before taking this latter interpretation too far, however, it is worth broadening our perspective to include the less well recorded burials. Figure 4.2 provides a frequency distribution of the number of grave-good categories in 51 Viking Age graves from the earldoms (excluding only 10 examples represented by stray finds). The result differs somewhat from Figure 4.1, with burials falling into two groups. The majority contained from one to four grave-good categories while a scatter of others yielded from five to 13 artifact types. If one is inclined to associate grave-goods with social status this pattern could be interpreted as evidence for the existence of a pyramidal social structure in which wealth (and its corollary, power) was concentrated in the hands of few individuals. This conclusion is not surprising and is consistent with interpretations of contemporary social organisation in Norway (e.g. Myhre 1993). It does clash, however, with egalitarian conceptions of west Norse settlement current in the 19th century (see Clouston 1932:157; Helle 1993:1).

Predictably, however, the interpretation of Figures 4.1 and 4.2 is complicated by weaknesses in the data set. There is an insufficient number of graves to justify firm conclusions (Orton & Hodson 1981:114). Moreover, the number of grave-goods may be underrepresented in many of the poorly recorded burials included in Figure 4.2. This bias could account for the apparent cluster of graves including from one to four artifact types. The grave data are thus of limited present value. Nevertheless, they are at least *consistent* with the presence of a local elite.

Anthropological models could be harnessed to the cause of social reconstruction. For example, Viking Age polities of Scandinavia have been conceived in the mould of Service's (1962) ideal types the chiefdom and (towards the end of the period) the state (e.g. Hodges 1989a:26-27, 185-198; Myhre 1993:182-183; Randsborg 1980:7-10, 168; 1982:132; see Earle 1991a for a recent review of chiefdoms cross-culturally). Without assuming that all cultures can be described in similar terms, however, it is possible to reach the following conclusions. Some individuals were able to overwhelm the native Iron Age population, to attract clients or a retinue which occupied defensible settlements and to amass extraordinary portable wealth (some of which took the form of explicit status symbols). If the medieval historical tradition is to be believed these power holders were called earls, inherited their right to authority and owed only nominal allegiance to the Norwegian throne.

The relationship of the earls of Orkney *vis-à-vis* their putative Norwegian overlords is illuminated primarily by the historical record. It would seem that the Viking Age colonies of Scotland lay within range of punitive military raids, but beyond the scope of systematic royal administration. For example, the earldoms may have been subjected to attack by Haraldr inn Hárfagri in the late 9th century (Pálsson & Edwards 1981:26; but see Sawyer 1976 and Smyth 1984:152-153 for alternative interpretations) and Earl Sigurðr Hlǫdvisson (and by default the earldom) was allegedly forcibly converted to Christianity by Óláf Tryggvason in 995 (Crawford 1987:69; Pálsson & Edwards 1981:37).

Both Norwegian and Scottish kings also pursued their interests in the north of Scotland by supporting rival claimants to the status of earl. This process becomes particularly evident after Caithness, the mainland portion of the Norse colony, began to be explicitly perceived as a separate earldom held by the rulers of Orkney as a grant from the Scottish Crown. This distinction is first expressed in *Orkneyinga Saga* in reference to Þorfinnr Sigurdarson (d. c.1065). He was granted Caithness by King Malcolm II of Scotland, and subsequently achieved virtually total control of both Orkney and Caithness (Pálsson & Edwards 1981:38-76). It has also been suggested that this distinction may date from several decades later, after the late 11th century expedition of Magnús Berfœttr to Scotland (Crawford 1985b:25; Duncan & Brown 1957:193-194). Although the earldoms were ostensibly distinct entities after the 11th century, they were effectively held as a single polity by the Earls of Orkney until 1375 (Crawford 1982:71).

It is likely that at least a substantial component of the Viking Age population of the earldoms adhered to a distinctive, non-Christian, world view. As discussed above, 61 pagan graves have been recovered from the earldoms, three from Shetland, 43 from Orkney and 15 from Caithness (including Sutherland) (Table 3.1).The role of ritual in the acquisition and maintenance of power is well documented cross-culturally (e.g. Mann 1986:21). However, the socioeconomic interpretation of Viking Age religion is complicated by issues of chronology. For example, a timber chapel at the possible elite centre on the Brough of Deerness has been dated to before 959-975 based on an Anglo-Saxon coin of Eadgar (Morris & Emery 1986:357). This conflicts with historical evidence that the earldom was forcibly converted in 995 (Crawford 1987:69; Pálsson & Edwards 1981:37), and that Christianity was only firmly established - with the erection of a bishop's seat at Birsay - in the reign of Earl Þorfinnr Sigurdarson (d. c.1065) (Pálsson & Edwards 1981:75; Morris 1990:17-19).

It is perhaps reasonable to assume that a degree of cultural fluidity, and religious syncretism, characterised the Viking Age in northern Scotland. This is certainly consistent with developments elsewhere in the Viking world (e.g. Graham-Campbell 1989:186-187; Fellows-Jensen 1987) and might be expected given some contact with a Christian native population (see Omand 1986). If this assumption is sound, it is probably reasonable to accept Morris and Emery's (1986:315-320; 366) suggestion that the timber structure at Deerness - complete with an 'altar' at the east end - represents the proprietary chapel of a secular Norse elite.

This unity of secular and ecclesiastical authority is certainly apparent in historical evidence allegedly referring to the 11th. The example of Þorfinnr Sigurdarson has already been mentioned, but deserves further attention. Þorfinnr built his Minster, the seat of Orkney's first bishop, following a pilgrimage to Rome (Pálsson & Edwards 1981:74-75). With this earl, one may see an attempt to legitimise authority through appeal to distant secular and ecclesiastical power centres. He used connections with the Scottish crown to enforce his initial claim to power in the earldoms. Perhaps his subsequent connections with Rome provided a mechanism to peripheralise older, possible pagan, factions within the colonies (see Myhre 1993:195).

The potential symbolic impact of these connections should probably not be underestimated. The early Viking Age (VA1) must have been a time of considerable geographic mobility for all Scandinavian settlers in the west. As the Viking Age waxed to the Late Norse Period, however, it seems likely that this mobility was increasingly constrained for all but the social elite. The onomastic evidence could be taken to support this argument. Place-names such as Langskaill (12 examples, six on Mainland alone) and Kirbister (eight examples) are extremely common in Orkney (Marwick 1952:233, 238-239). One might expect a proliferation of identical names in close proximity only where movement was quite local in character. Conversely, Þorfinnr spent time at the courts of Scottish, Norwegian and Danish kings and traveled as far as Rome (Pálsson & Edwards 1981:38, 47, 72, 74-75). It is difficult to imagine that the propaganda value of this privileged access to royal and religious authority was left unexploited.

The precise extent of Norse control on mainland Scotland is difficult to pinpoint, as its boundaries were rather fluid over the 600 years or more of Scandinavian influence (see Section 1.2). Nevertheless, it is evident that the power of the earls was at times of considerable geographical scale. Medieval historical tradition suggests that the first earl of Orkney, Sigurðr Eysteinsson, conquered much of Northern Scotland (in cooperation with Þorsteinn Rauðr, a son of King Óláfr inn Hvíti of Dublin) and died after fighting near the River Oykel, Sutherland (Pálsson & Edwards 1981:28). Sigurðr Hlǫðvisson (d. 1014) may have claimed tribute from the Western Isles (Magnusson & Pálsson 1960:182) and is thought to have married a daughter of King Malcolm II of Scotland (Pálsson & Edwards 1981:38). The *Orkneyinga Saga* also claims that his son, Þorfinnr, held nine Scottish earldoms, the Hebrides and part of Ireland (Pálsson & Edwards 1981:75). He probably effectively divided control of Scotland with his cousin MacBeth (Donaldson 1990:57).

Onomastic evidence is not inconsistent with these historical traditions. Certainly Scandinavian place-names indicate the potential geographical extent of Norse control (Nicolaisen 1976:86-96; Fraser 1986). Figure 4.3 illustrates the distribution of three Norse settlement names, *staðr*, *setr/sætr*, *bolstaðr*, and a single topographic name, *dalr*. Nicolaisen (1976:92, 96) has suggested that these elements illustrate the spheres of maximum Norse occupation and influence respectively. However, subsequent replacement of Norse elements by Gaelic and Scots names is not an insignificant problem. This difficulty is particularly acute in Sutherland and Caithness where many

Norse names were probably replaced prior to adequate written record (Fraser 1986:23, 29; Waugh 1993:121, 127; see Dorian 1981:10-15; Fellows-Jensen 1984:148). For example, Strathnaver (Sutherland) may have replaced an earlier Norse name preserved today as Torrisdale Bay (see Macaulay 1991:283).

Despite these problems, both the historical and place name evidence suggests that the Dornoch Firth and River Oykel were considered boundaries for at least some periods of Scandinavian rule in the North (Crawford 1986:33; Fraser 1986). One place name, *Cyderhall* near Dornoch, is of at least curiosity value in this regard. Thirteenth century records of the name (*Sywardhoth, Sytheraw*) reveal that it is probably a corruption of 'Sigurd's Howe', perhaps a reference to Sigurðr, first earl of Orkney, who (as mentioned above) may have died c.892 while on campaign near the banks of the Oykel (Crawford 1987:58-59; Fraser 1986:31). It is also evident, however, that Scandinavian influence occasionally extended further south. The place-name *Dingwall* (at the head of the Cromarty Firth, north of Inverness), probably from *þingvǫllr* meaning assembly plains, is particularly suggestive (Fellows-Jensen 1993).

Archaeological evidence is also suggestive. Hoards have been recovered as far south as Tarbat on the east coast, and are common in the Western Isles (Graham-Campbell 1995:10-11). The Hebrides and Man probably represented a separate polity for much of the Viking Age (e.g. Smyth 1984:155). As already mentioned, however, they may have been brought into a tributary relationship with Orkney during the reign of earls such as Sigurðr Hlǫðvisson (Magnusson & Pálsson 1960:182). The discovery of 'ring-money', thought to be a form of currency imposed by the earls of Orkney (Crawford 1987:133-134), in 10th-11th century hoards from the Hebrides and Man provides some support for this interpretation (Graham-Campbell 1976:129-130; 1983:74-78; Dolley 1981:175).

4.4 The Late Norse Period 1 (11th - 13th centuries): An autonomous Christian polity

In this study, the date of transition from the Viking Age to the Late Norse Period has been left purposefully vague - the 11th century. The most explicit discussion of the VA/LN distinction to date has been offered by Gerald Bigelow. Building on Hamilton's (1956) interpretation of Jarlshof, Shetland, he considers the transition to be marked by three trends: "increased dairying", "increased procurement of large fish" and "increases in the importation of durable goods from Norway ... [marking] growth in trading activities" (Bigelow 1989:189).

Although originally well supported, some of Bigelow's conclusions are open to reinterpretation on the basis of recent evidence from Orkney and Caithness. Specifically, it is evident that long range trade was a facet of both Viking Age and Late Norse society (see Chapter 6 below). Moreover, the date at which a putative export trade in cured fish began is a matter of some uncertainty (see Sections 7.4 and 9.4 below). Finally, the hypothesis that dairying was intensified in the Late Norse Period may not be sustainable - particularly for Orkney and Caithness (see Section 5.5 below).

Despite these specific reassessments of Bigelow's proposed chronology, it *is* evident that the 11th century entailed major social changes in the colonies of Scandinavian Scotland. Pagan burial declined (Table 4.1), as did unrecovered silver hoards (Table 6.6). Christianity was formally established and old status markers such as ball-type brooches may have been abandoned - possibly in favour of the monumental architecture which is certainly well established by the 12th century (Appendix 3.2). As discussed above (and in Chapter 6 below), these patterns may reflect profound social changes: an increasing centralisation of power, lower levels of internecine conflict and increasing reliance on taxation (rather than military plunder) as a basis of wealth and power.

Precise dating of these changes is impossible, but broad chronological patterns are identifiable. The dating of most pagan graves is ambiguous, but none are known to definitely postdate the 900s and burials without grave-goods certainly appear by the 11th century (e.g. Driscoll 1990:29-37; Morris & Emery 1986:323-325, 347-348, 350, 357-358; see Table 4.1). The latest unrecovered hoard of Viking Age character (Dunrossness Manse, Shetland) was probably deposited c. 1065, but it is an outlier in a distribution which otherwise terminates c.1035 with the Caldale Hoard, Orkney (Graham-Campbell 1993:184; Table 6.6). Brooches and other examples of 'elite' metalwork (imported objects often incorporating precious metals) largely disappear with their primary find contexts - hoards and graves (Appendix 3.3; Table 6.6). Moreover, their occurrence at settlement sites such as the Brough of Birsay (Curle 1982:63-64, 78-79, 101) and Jarlshof (Hamilton 1956:128, 140-141, 150) is essentially limited to Viking Age phases. Bronze ringed-pins of possible Late Norse date have been recovered at sites such as Tuquoy (Owen 1993:377) and Freswick (Batey 1987a:117, 144), but these are hardly comparable with the elaborate ball-type, oval and trefoil brooches of earlier date.

The first two centuries of the Late Norse Period were not without conflict and change. Nevertheless, the archaeological and historical evidence is consistent with a relatively stable, wealthy and independent Christian polity. The adjective stable deserves some explanation. The 12th and early 13th centuries (for which narrative accounts such as *Orkneyinga Saga* are most reliable) were not without intrigue and conflict among rival claimants to authority in the earldoms (e.g. Dasent 1894b:155-156; Pálsson & Edwards 1981:39, 43, 47, 59, 63, 71, 83-84, 90-94, 99-100, 118, 120-123, 137-139, 183-188, 192-198, 210-211, 220-224). Despite these quarrels, however, a single 12th century bishop is said to have served for 66 years (Bibire 1988:221) and magnates such as Sveinn Ásleifarson flourished under successive rulers (Pálsson & Edwards 1981:137-218). Moreover, for much of these centuries, single earls held dominance during extended reigns. Examples include Hákon Pálsson (reign c.1103-c.1123; see Pálsson & Edwards 1981:97-98), Rǫgnvaldr Kali Kolsson (reign 1136-1158; see Pálsson & Edwards 1981:142-214), Haraldr Maddaðarson (reign 1138-1206; see Pálsson & Edwards 1981:214-224) and Jón Haraldsson (reign 1206-1230; see Dasent 1894b:27, 45, 77, 90, 134, 149, 152, 155-156; Guðmundsson 1965:298-300; Pálsson & Edwards 1981:224).

The wealth of the earldoms is most vividly expressed by monumental architecture. Secular examples include 12th century towers or castles such as The Wirk, Rousay (Clouston 1931; Lamb 1993b:53-54), 'Cubbie Roo's' Castle, Wyre (Lamb 1980a:94; RCAMS 1946a:235-239), and the Castle of Old Wick, Caithness (Lamb 1980a:90-96; RCAMS 1911b:137-139; Talbot 1974:40). The greatest expressions of Late Norse wealth, however, are ecclesiastical structures such as St. Magnus Cathedral, Kirkwall (largely built, in its earliest form, between 1137 and 1150 [Cruden 1988:83-84]), The Bishop's Palace, Kirkwall (possibly of 12th century origin [Simpson 1961]), St. Magnus Church, Egilsay (thought to date to the early 12th century [Fernie 1988:159]), and a plethora of possibly private churches at sites such as Orphir (Fisher 1993), Birsay (Morris 1990:22-24) and Deerness (Morris & Emery 1986) (see also Cant 1984). Much of this work, however, can also be considered as an expression of secular wealth. Scandinavian churches were predominantly under direct political patronage until well into the 12th century (Helle 1988:53). Even St. Magnus Cathedral, the greatest of the ecclesiastical undertakings (comparable in scale to contemporary parallels in Scotland and Scandinavia), was the private project of Earl Rǫgnvaldr Kali Kolsson (Cambridge 1988:122-124; Pálsson & Edwards 1981:142).

The wealth of Orkney and Caithness is also implied by successive attempts to usurp control of the earldoms (and thus, presumably, of access to rents and tax). For example, Magnús Berfœttr took control of the Islands by force in the late 11th century and placed his son, Sigurðr over them as earl (Pálsson & Edwards 1981:83-84). After the death of Magnús, however, Sigurðr returned to Norway as king and the heirs of the previously deposed earls assumed power (Pálsson & Edwards 1981:88-89). In the 1130s, a Norwegian born nephew of Earl Magnús Erlendsson, (murdered 1115) successfully usurped control of Orkney. However, it is perhaps indicative of the newfound stability of the earldom that Kali Kolsson found it appropriate to change his name to that of a previous earl, Rǫgnvaldr, and to build a cathedral in honour of his martyred uncle (Pálsson & Edwards 1981:108-142). In the mid 12th century an earl required legitimacy beyond simple military conquest.

More explicit expressions of wealth include incidents such as Earl Haraldr Maddaðarson's reconciliation with King William the Lion of Scotland in 1202. Haraldr was able to pay 2000 pounds in silver to placate the Scottish monarch and recover his rights to Caithness after military clashes between the two (Skene 1993[1872]:272; see Crawford 1985b:32). To put this figure in wider perspective, it is approximately 3/4 of the value of 4000 merks sterling (£2667) paid to Norway by Alexander III for the permanent annexation of the Western Isles (Donaldson 1974:36).

The expansion of the Viking Age was largely over in the early centuries of the Late Norse Period. Nevertheless, the earldoms remained largely intact and independent. They were still within range of punitive royal attack, but (with a few short term exceptions) beyond the reach of practical administration by Norway or Scotland (see Crawford 1985b; Pálsson & Edwards 1981:83-84, 183). The evidence for independence includes (occasionally counterproductive) rebellion and conflict with King William the Lion of Scotland (Pálsson & Edwards 1981:221-224; Skene 1993[1872]:270-272; Stubbs 1871:10-12) and King Sverrir Sigurðarson of Norway (Pálsson & Edwards 1981:224; Sephton 1899:146-152, 156). In 1201, Earl Haraldr Maddaðarson went so far as to have the Bishop of Caithness - a Scottish appointee - mutilated (Johnston & Johnston 1907-1913:24-26; Pálsson & Edwards 1981:222; see Crawford 1993).

Above all, the Late Norse earldoms were explicitly Christian. The evidence of ecclesiastical architecture has already been mentioned. It is likely, moreover, that a parish system and ecclesiastical dues such as tithes and 'Peter's Pence' were instituted in the 12th century (Crawford 1974:17-22; Sawyer 1988:40-41; Johnston & Johnston 1907-1913:22-23). The church was developing as an independent power, able to exert considerable influence in secular politics. For example, Bishop Vilhjálmr of Orkney's decision to canonize Magnús Erlendsson in the 1130s (Pálsson & Edwards 1987:36-37) can probably be interpreted as a shift in allegiance from Earl Páll Hákonarson to the aspiring usurper Rǫgnvaldr Kali Kolsson (Thomson 1987:61-62).

The earls of Orkney embraced this pan-European ideology wholeheartedly. The construction of proprietary churches has already been mentioned and Earls Hákon Pálsson and Rǫgnvaldr Kali Kolsson mounted expeditions to Jerusalem. The evidence is historical (Pálsson & Edwards 1981:97, 164-179), but may be corroborated by runic graffiti in the chambered tomb of Maeshowe (Barnes 1993:366).

The socioeconomic importance of Christianity cannot be overemphasised. It was the medium via which the Late Norse earldoms were incorporated into a wider European system of social and economic connections. Bishop Vilhjálmr of Orkney was educated in Paris (Pálsson & Edwards 1981:161). St. Magnus Cathedral was built following the English model of Durham, possibly even by English masons (Cruden 1988:82). Earl Rǫgnvaldr was able to socialize in the French court of Narbonne where he and his retinue composed poetry in the current European fashion of 'courtly love' (Bibire 1988:219).

It was also Christianity -through obligatory fasts such as Lent - which helped create the huge European demand for cured fish. This demand fueled the incorporation of Arctic Norway - a principal producer of dried fish from at least the early 12th century - into the Norwegian state and a wider medieval world (Bertelsen 1992; Urbanczyk 1992:230-239). It may not be unreasonable to suggest, as argued in Chapters 6 to 9 below, that similar processes might have occurred in Scottish Norse colonies less well served by early historical records.

4.5 The Late Norse Period 2 (13th - c.1416): Contraction and 'Scottification'

Historical evidence provides much of what is known regarding the final two centuries of the Late Norse Period. The foundations for change from LN1 to LN2 were perhaps laid in the second quarter of the 12th century. In 1130 David I of Scotland defeated Earl Angus of Moray, installed new feudal dynasties in the northeast and extended effective royal control to the southern margin of Scandinavian influence in the North (Barrow 1981:33). Caithness was erected as a separate bishopric at much the same time, presumably separated from the diocese of Orkney (Crawford 1993:131). This change was almost certainly at the direction of David I, who was redrawing the Scottish ecclesiastical map, and served to place a representative of royal interests in the far north (Barrow 1981:67-68; Crawford 1985b:27-28; 1993:134).

The resulting conflict ultimately led to the first unquestionable royal Scottish campaigns in Caithness. William the Lion is said to have brought an army as far north as Thurso, and to have destroyed Earl Haraldr Maddaðarson's Castle there in 1196 (Stubbs 1871:10; see also Pálsson & Edwards 1981:221-224; Skene 1993[1872]:270, 272). Although Haraldr was ultimately able to reaffirm his claims to Caithness (Skene 1993[1872]:272), his mainland possessions were at times removed from his control (Stubbs 1871:11-12). Moreover, feudal magnates of Moray, the de Moravia dynasty, acquired possession of substantial portions of Sutherland around the turn of the 13th century (Crawford 1985b:32-33).

Concurrent with these developments, the earldoms were also suffering royal pressure from Norway. After the failed rebellion against Sverrir Sigurðarson in 1194, the king confiscated Shetland, the estates of participants in the battle of Florevaag and a portion of the Earl's income from Orkney (Sephton 1899:156-157). Although estates of the rebels could be redeemed by their heirs with money payments, Shetland remained under direct royal control thereafter. Moreover, royal officers took up residence in the islands to manage and enforce the collection of tributary payments from the confiscated lands (Sephton 1899:156-157). *Orkneyinga Saga* records earlier incidents involving royal officials (both Norwegian and Scottish) in the earldoms, but their presence appeared sporadic and occasionally ended with their expulsion or death (Pálsson & Edwards 1981:37-38, 51, 71, 84-88). After the events of 1194 they were probably permanent features of the Orcadian political landscape (see Clouston 1914:4, 6; Dasent 1894b:155; Donaldson 1974:36).

Thus, by the early 13th century the earls of Orkney had officially lost control of Shetland, effectively lost control of Sutherland, and occasionally lost control of the rest of Caithness as well. Moreover, they had to share authority with Norwegian royal officials and, on the Mainland, with a Scottish Bishop. This contraction of political independence continued into the 13th century. In 1222, King Alexander II of Scotland took direct revenge for the burning of Bishop Adam of Caithness by the farmers (*bœndr*) of the earldom (Guðmundsson 1965:299-300). According to the Icelandic Annals eighty men had a hand and foot removed (Storm 1888:126, 185). In 1230, Earl Jón Háraldsson of Orkney was murdered in Thurso due to a private dispute with a hirdman of king Hákon Hákonarson (and guest of the king's representative in the earldoms) (Dasent 1894b:155-156). The passengers of the "göðingaskip," presumably Jón's kin and other elite representatives of the earldoms, were drowned on return from the resulting trial in Bergen in 1232 (Crawford 1985b:33-34; Dasent 1894b:157-158; see Clouston 1932:159-160 and Guðmundsson 1965:85 for use of the term *gœðnga* to denote the kin of Earl Páll Hákonarson and other Orcadian magnates). Jón died without heir, and alternative local leaders were eliminated in a single shipwreck. It is likely that the earldom of Sutherland was carved from Caithness, and given to William de Moravia, during the succeeding period of uncertainty (see Crawford 1985b:33; Bannatyne Club 1855:77). A few years earlier, c.1223, the diocese of Caithness had been granted to Gilbert de Moravia, a member of the same dynasty (Watt 1969:58). Gilbert moved the focus of the bishopric from Halkirk and Thurso in the north to Dornoch, within the sphere of his families expanding influence (Crawford 1985b:27; 1993:132-133; Slade & Watson 1989:299-301).

By 1235-1236, Orkney and the remainder of Caithness were granted to Magnús II, a relative (perhaps a son) of the earl of Angus and possibly a descendant of Haraldr Eiríksson (the grandson of Earl Rǫgnvaldr Kali Kolsson). In 1236, in Inverness, Magnús was the first earl of Orkney and Caithness to witness a Scottish royal charter. The earls had become vassals of their royal suzerains in fact as well as name. Moreover, at Magnús' death in 1239 half of the remaining earldom of Caithness (including Strathnaver on the north coast) also came into control of the de Moravia family through marriage of his heiress, Joanna (Crawford 1985b:34-36; see also Crawford 1982:65).

The relationship of Magnús II and his successors with Norway is somewhat ambiguous. Orcadians were occasional visitors to King Hákon Hákonarson's court (Dasent 1894b:217). However, it is not until the events surrounding Hákon's military campaign in the Hebrides, in 1263, that the situation is illuminated with any clarity. Earl Magnús III was provided with a ship by the Norwegian king, and must have been thought a trustworthy ally (Dasent 1894b:345). The earl disappears from accounts of the campaign, however, and it was Bishop Henry of Orkney who lodged the king on his return from the west (Dasent 1894b:345-367). As Barbara Crawford (1985b:38) has suggested, Magnús may have found it impractical to participate in a conflict between his Norwegian and Scottish overlords.

The 14th and early 15th centuries represent a continuation of the processes of 'Scottification' and contraction. In 1321 Earl Magnús V died without heir and (in 1331, after a period of confusion) control of Orkney and Caithness fell to Malise, earl of Strathearn (Crawford 1982:66-68). Crawford perceives this as a watershed in the history of the northern earldoms. "For the first time the earl of Caithness and Orkney was a major Scottish magnate by virtue of his other possessions" (Crawford 1982:68). In the century following this succession the earldom of Caithness was sold to the Scottish crown (by Alexander de Ard in 1375 [Bannatyne Club 1855:79]) and Norse began to die out as the language of the northeast mainland (c. 1400 [Waugh 1986:99]). The Scottification of Orkney also progressed apace. In 1321 Robert Bruce wrote to the baillies of the king of Norway in Orkney requesting better treatment for "... men of our country dwelling among you ..." (Clouston 1914:7) and Bishop William of Orkney's employment of foreign, presumably Scottish, men led to conflict in 1369 (Clouston 1914:17). The last known Norse document written in the islands dates to 1425 (Thomson 1986b:218).

This study ends in 1416, the year in which direct trade with Orkney and Shetland was begun by the Hanseatic league (Friedland 1973). After this date, trade patterns are relatively well documented and may differ considerably from preceding centuries (Fridland 1973; 1983). The Late Norse Period is therefore terminated in the early 15th century, rather than with the traditional dates of 1468-69 in which Orkney and Shetland were ceded to Scotland by Denmark (Donaldson 1974:85-87).

The Late Norse Period 2 was without doubt a time of diminishing independence for the earls of Orkney and Caithness. For much of the period, however, the wealth of the earldoms may have been redistributed, rather than reduced. Monumental architecture continued to be built, if occasionally by rivals of the earls. Dornoch Cathedral, for example, was built by Bishop Gilbert de Moravia in the second quarter of the 13th century (Gifford 1992:562-566; RCAMS 1911a:36). Examples within lands still held by the earls (see Crawford 1982:67) include additions to St. Magnus Cathedral (Cruden 1988:85; Fawcett 1988:105-106) and castles such as Forse and Braal, Caithness (Gifford 1992:107, 117). Moreover, silver hoards (associated with the unsettled years of the early 14th century) have been recovered at Ladykirk and possibly Braemore, Caithness (Stewart 1973:135, 139). The Ladykirk hoard, with a minimum of 82 silver sterlings (Archibald & Woodhead 1975:94), represents a modest but notable concentration of wealth. Although tiny in comparison with 14th century hoards of thousands of coins known from medieval burghs such as Aberdeen (Mayhew 1989), it is consistent with the size of many smaller examples from Scottish rural contexts (see Metcalf 1977:26-44).

Tithe records from 1327 also show the not insubstantial wealth of Orkney *vis-à-vis* other North Atlantic regions. The six years tithe for Orkney was over three times that of Greenland and approximately half that of Norwegian dioceses such as Stavanger and Hamar (Keller 1991:138). It must also be relevant that lands in the earldoms were attractive to the already wealthy Scottish dynasties of Moray, Angus and Strathearn. Some later quantitative evidence may put their potential wealth in wider Scottish perspective. The rental value of Orkney alone (through the collection of rents, taxes and perhaps produce from proprietary farms of earl and king) was over £11600 in the 1590s (Anderson 1992:155). Using Scottish price summaries for the 1530s published by Gemmill and Mayhew (1995), this might equate to approximately 7700 cows, 52500 sheep, 17600 bolls (c.1155000 litres) of malted barley, 464000 pounds of butter or 27000 pounds of wool.

It is likely, however, that the earldoms suffered a significant depression in the 14th and/or 15th centuries (Thomson 1984). The 1492 Sinclair rental suggests that nearly 50% of previously taxed land lay out of use (Thomson 1984:128). While largely outwith the study boundaries, this catastrophic change may be relevant to the final years of the Late Norse Period. Its causes deserve further research in the future, but the plague which "ravaged" Orkney in 1349 (Thomson 1987:111) is known to have fundamentally undermined the economy of Norway (Urbanczyk 1992:240-248). The potential impact of the Little Ice Age on agricultural production may also be relevant (see Section 2.6 above).

4.6 Chapter Summary

In summation, it is evident that the authority, independence and wealth of the earls of Orkney fluctuated throughout the six centuries of the Viking Age and Late Norse Period. In particular, LN2 was probably a period of decreasing political autonomy, redistribution of wealth (from the native elite to new royal representatives) and agricultural decline. Nevertheless, there is considerable evidence that the earldoms were wealthy and sought after (by kings and rival earls) from the beginning of the Viking Age to the post-medieval period. Moreover, the success with which a native elite resisted systematic royal control implies the considerable resources at their disposal for the maintenance of military power. The possible sources of this wealth are investigated in the chapters to follow. Occasional royal expeditions suggest that northern Scotland was not so remote, particularly from Norway, for geography to be its only defense.

PART II

SOURCES *of* WEALTH

Chapter 5
Primary Sources of Wealth: The subsistence economy

5.1 Introduction

If the earldoms - or more precisely earls and other members of the Orcadian elite - were wealthy, what were the sources of this wealth? In due course, I would like to investigate whether it derived in part from participation in a European cured fish trade. To put this possibility in its socioeconomic context (and to avoid predetermining conclusions), however, it is necessary to address other potential origins of wealth. For the sake of convenience, these can be divided into primary and secondary sources. The former constitute activities typically identified with the subsistence economy: arable agriculture, pastoralism, fishing, fowling, hunting and collecting (a catch all category including gathering materials such as peat, driftwood and seaweed). The latter are: piracy, taxation, mercenary activity, shipping tolls, provisioning shipping, piloting and export trade. The distinction between the two groups is somewhat arbitrary. In particular, primary sources of wealth provide the bases of secondary sources such as internal taxation and export trade. Nevertheless, fundamental activities such as arable agriculture, pastoralism and fishing provide a logical starting point for any discussion of Viking Age and late Norse economy. This chapter thus entails a detailed discussion of evidence regarding the subsistence economy of Norse Orkney, Caithness and Shetland. Secondary sources of wealth are considered in Chapter 6.

Ecofactual remains - principally botanical macrofossils and bones - are by far the most important sources of evidence for subsistence activities in the earldoms. Recent theses by Colin Andrew (1994) and Julie Bond (1994) have discussed the botanical data at length. Archaeobotanical evidence will thus be considered rather briefly in this study. Conversely, zooarchaeological evidence regarding pastoralism, fishing, fowling and hunting has not been synthesised. This material is thus of primary present concern.

The chapter is divided into several distinct sections. Section 5.2 is a methodological digression which explains techniques of zooarchaeological quantification used in this and subsequent chapters. It surveys the capabilities and limitations of zooarchaeological inquiry and presents new research regarding the use of bone weight to quantify zooarchaeological assemblages. Section 5.3 reviews faunal and botanical assemblages considered in the thesis. Sites which have been published (or otherwise disseminated) are summarised in Appendix 5.1 and Tables 5.1-5.2, where the reader is directed for references and to clarify points of chronology or methodology. Conversely, it was considered necessary to include detailed discussions of unpublished assemblages from three projects with which the author has been involved: Earl's Bu (Section 5.3.1), Robert's Haven (Section 5.3.2) and Freswick Links (Section 5.3.3). Subsequent to this background information, Sections 5.4-5.9 provide critical discussions of the evidence regarding arable agriculture, pastoralism, fishing, fowling, hunting and collecting.

5.2 Quantifying Zooarchaeological Assemblages: A methodological digression

5.2.1 Introduction

The fundamental objectives of zooarchaeological inquiry usually include:

1) estimation of the relative abundance of different animals or parts of animals (Grayson 1984; Ringrose 1993),

2) estimation of the relative potential meat yield of different animals or parts of animals (Barrett 1993; 1994; White 1953),

3) reconstruction of age at death profiles of different taxa (which can yield information regarding the exploitation of secondary products such as milk or wool) (Amorosi 1989b; Legge 1981; McCormick 1992; Moran & O'Connor 1994; Payne 1973; Silver 1969; see papers in Wilson et al. 1982) and

4) assessment of the effect of taphonomic and recovery biases on results from each of the aforementioned procedures (Lyman 1994; Marean 1991; Morlan 1994).

Although these goals remain relatively constant, the precise methods used to approach them differ between workers. A comprehensive overview of zooarchaeological practice is beyond the scope of this thesis. However, methods employed below require some introduction.

The present discussion is limited to methods for the interpretation of taphonomic biases, the relative abundance of different taxa and the relative potential meat yield of different taxa. I focus particularly on the latter, because the measure employed - bone weight - has received somewhat misplaced criticism in the past (e.g. Casteel 1978; Jackson 1989). Issues regarding the reconstruction of age at death profiles are left to a short discussion in Section 5.5 below. Although this procedure is of great interpretive importance, proper review of the associated complexities would constitute a lifetime of research. Interested readers are referred to the papers cited in number 3 above.

5.2.2 Assessing Taphonomic and Recovery Biases

Palaeoeconomic research requires the reconstruction of death assemblages (carcasses from which food and nonfood products were cut) and life assemblages (live population of animals which yielded products such as milk and wool) from archaeological assemblages (bones which are ultimately recovered and analysed) (see Lyman 1994:19). Virtually all methods of quantifying faunal remains measure the archaeological assemblage in the first instance. It is necessary to qualify data such as fragment counts or bone weight in order to reach an understanding of the death and life assemblages of ultimate interest. The exceptions to this rule, statistical techniques used to estimate a *probable number of individuals* (Fieller & Turner 1982; Ringrose 1993:128-129; Winder 1991), require essentially unobtainable information - the identification of pairs of elements from single skeletons (see Barrett 1992a:20-21; Gautier 1984:24).

Characteristics of life assemblages - such as the age profile and species composition of herds - can theoretically be reconstructed from death assemblages (see Section 5.5 below). However, experimental and ethnographic evidence illustrate the degree to which archaeological assemblages are likely to be biased representations of death assemblages. Two factors (sometimes considered together) cause this discrepancy: taphonomic processes (all factors of transport and destruction which affect the survival of bone) and recovery methods (including excavation location and bone collection strategy). Figure 5.1 provides a schematic model of the transformation from death assemblage to excavated and analysed sample.

Taphonomic processes can affect measures of both relative abundance and potential meat yield (see Greenfield 1988; Walters 1984:395,397 for examples involving bone counts and weight respectively). Moreover, the degree of attrition often varies among animals of different age, size or taxon (Greenfield 1988; Lyon 1970; Nicholson 1992a; Walters 1984; Wilson 1985:83), and among different skeletal elements of a single species (e.g. Binford & Bertram 1977; Butler & Chatters 1994; Grayson 1989; Lyman 1984; 1994:223-293). A wide variety of processes account for these biases. Bones can be discarded 'off site' - fish bones, for example, were sometimes disposed at sea or on agricultural fields in early historic Orkney (Colley 1986:35; 1990:216; Withrington & Grant 1979[1791-1799]:244). Bones can be broken during food processing, weakened by cooking or destroyed by disposal in fires (e.g. Colley 1986:38; Lyman 1994:389-391; Nicholson 1992a, 1993b). They can be damaged by dogs, pigs and wild carnivores (e.g. Colley 1986:38; Greenfield 1988; A. Jones 1984; Kent 1981; Lyman 1994:205-216; Lyon 1970; Payne & Munson 1985; Walters 1984; see Section 8.3.5 below). Even when undisturbed by scavengers, bones deposited on the surface may suffer damage from trampling, sun, water action and microscopic organisms (Lyman 1994:354-403). Those bones which survive to be buried are subsequently affected by soil acidity, root action and other soil conditions (Carbone & Keel 1985:11, 14; Linse 1992; Lyman 1994:375-377). Leaching, mineralisation and adhering soil can alter the weight of bones (Casteel 1978:77; Gilbert & Singer 1982:31; Hesse & Wapnish 1985:112; Lyman 1979:538).

In sum, taphonomic processes can lead to the destruction of more than 90 percent of an assemblage of discarded bone. In a study of dog scavenging Ian Walters (1984:395,397) was able to recover only two percent of approximately 4900 grams of bone discarded at his campsite over a six-month period. Similarly, A. Bullock and Andrew Jones (in Jones 1990:114) were able to recover less than one percent of the bones of 20 herring and five mackerel which had been left in rural Wales for five weeks. Haskel Greenfield (1988) found that more than 90 percent of sheep and pig bones fed to pigs in a Serbian village were quickly consumed. Bone destruction may not *always* be extensive, but it would be wise to assume a large gap between original death assemblages and the bones which are eventually analysed. This applies to both absolute quantities of bone and to the relative proportion of taxonomic and age groups with different preservation characteristics.

Appropriate analytical procedures can facilitate some quantification of taphonomic destruction (e.g. Marean 1991; Morlan 1994). This issue is discussed in Section 7.2 below in the context of assemblages analysed by the author. Conversely, a non-quantitative approach is of greatest use in this chapter as data collected by several workers (and of differing quality and quantity) are compared. It is sometimes possible to suggest the probable direction of taphonomic bias even when faunal assemblages have been analysed using a variety of strategies. For example, the bones of fish, small- to medium-sized animals and young mammals are particularly vulnerable to destruction (Greenfield 1988:478; Jones 1991a:94; Lyon 1970:214; Nicholson 1992a; Walters 1984:395; Wilson 1985:83). Nicholson (1992a) and Jones' (1991a:94) research regarding the survival of fish bone is particularly relevant to the present study. They have experimentally demonstrated that the bone of gadoid fish (which dominate the assemblages under study, see Section 5.6 below), is probably more susceptible to physical attrition than mammal bone. Given the incomplete ossification of some fish bone (Butler & Chatters 1994; Meunier 1992) it is also likely to be most susceptible to chemical processes. In contexts where bone preservation is poor - as observed or measured - it is probably reasonable to expect the abundance and weight of fish to be disproportionately affected.

Recovery factors are also of great importance. Two categories of potential bias are involved. First, the choice of excavation location, and thus feature types recovered, will undoubtedly affect the results of palaeoeconomic reconstruction. As discussed in Section 3.5 above, sites are (to a greater or lesser degree) arbitrary windows in a landscape of archaeological deposits from diverse cultural activities. No one deposit is likely to reveal evidence regarding all aspects of a palaeoeconomy in proportions indicative of their society-wide significance. This issue involves both inter-site and intra-site variability in cultural deposits. The current chapter primarily addresses inter-site variability - partially in order to provide a broad overview of subsistence activities and partly because ecofactual data have not always been published at the context level. Intra-site variability is addressed in Chapter 7, where attention focuses on more detailed data from three sites: Earl's Bu, Robert's Haven and Freswick Links.

The second potential recovery bias is the degree to which excavated sediment is sieved to prevent loss of small bones (including most or all elements from small animals and the smaller bones of large animals). The impact of sieving strategy on recovery, particularly of bird and fish bone, has been demonstrated by a number of studies (e.g. Clason and Prummel 1977:174; Colley 1990:212; Jones 1982; Payne 1972, 1975, 1992; Stewart 1991). These classes will be substantially underestimated if little or no sieving with fine mesh is conducted. Payne (1992:2), for example, recommends the use of 2mm mesh for comprehensive recovery of fish bone.

The assemblages considered in this study have been recovered using techniques which vary from hand collecting to sieving with 0.895mm mesh. The proportion of excavated sediment sieved also varies widely. In the discussion to follow (see summary in Table 5.1), the degree of sieving has been grouped into five broad categories: none, minimal, partial, substantial and total. *None* and *total* are relatively self-explanatory (although see Section 5.3.1 below regarding Earl's Bu). *Minimal* includes assemblages where a tiny proportion of bone (<c.10%) was recovered by sieving. *Partial* and *substantial* indicate assemblages where (respectively) less than or greater than 50% of the excavated sediment was sieved. The categorisation of assemblages has sometimes been based on implicit rather than explicit information. It should thus be used only as a broad guide.

It is ideal to compare only assemblages recovered by identical strategies. Given the available data, however, this is unworkable in practice. An alternative approach is adopted below. Recovery strategy is noted on figures and qualitatively considered in narrative interpretations.

5.2.3 Assessing Relative Abundance and Potential Food Yield

How are archaeological assemblages to be measured? Two fundamentally different approaches are possible. One suite of techniques attempts to estimate the number of animals represented in a faunal assemblage. Fragment counts and minimum number of individuals (MNI) estimates - including the more detailed variant, minimum number of elements (MNE), sometimes used to assess the relative abundance of different parts of animals - are the most common examples. A second approach includes techniques which attempt to assess the relative potential meat yield represented by each category of bone. Of these techniques, only the weight method is considered in detail. A second method, which involves multiplying MNI estimates by an average meat weight for an individual of the taxon in question (Reed 1963:214; White 1953), has been heavily criticised and modified in recent decades (e.g. Lyman 1979; Smith 1975; Stewart & Stahl 1977). The method is particularly inappropriate for assemblages including fish. They grow throughout their lives, making 'average' weight estimates meaningless (Parmalee 1985:76).

Although the methods used to derive minimum number of individuals estimates vary slightly among workers (see Chaplin 1971; Flannery 1967; Lyman 1979; and White 1953 for classic examples), the basic premiss is to count the most abundant single element (e.g. right femur) of each analytical category. Presumably that element has survived better than the others and is most representative of the number of animals originally deposited. A version of MNI estimates, the minimum number of elements, has been used in studies of human and non human carcass processing (e.g. Stiner 1991:106). The principle is similar, but distinct portions of elements (diagnostic zones) are used to calculate the minimum number of each bone represented in an assemblage. MNI techniques have been the subject of considerable criticism (e.g. Gautier 1984:245; Grayson 1984) and it is not uncommon for bone reports to use only fragment counts (e.g. Amorosi 1991; Amorosi et al. 1992; 1994; Greenfield 1991; Lyman 1989:73; McGovern 1985; 1994). Nevertheless, many zooarchaeologists continue to employ some version of MNI, or to follow the advice of Klein and Cruz-Uribe (1984:37) to use several measures of faunal abundance. This applies to both practical studies (e.g. Bond 1994; Hoffecker et al. 1991; Marshall & Pilgram 1991; Stewart 1991; Stiner 1991) and theoretical discussions (e.g. Crabtree 1990:159-160; Davis 1987:36; Ringrose 1993; Wheeler & Jones 1989:136).

Debate over the legitimacy of MNI estimates is somewhat irrelevant to the present study. Only fragment counts are consistently used to quantify the available faunal assemblages from the Viking Age and Late Norse earldoms. In the interest of inter-site comparison, fragment count data will be used. In a single exception, where MNI estimates alone are available (Wheeler 1976-1977), only the presence or absence of taxa is considered.

Fragment count (or NISP, "numbers of identified specimens") data are calculated by counting the pieces of bone attributable to each taxonomic or anatomical category of interest. The resulting figures are assumed to bear some resemblance to the number of animals represented by the remains (Chaplin 1971:64). However, the connection between numbers of fragments and numbers of animals is complicated by two factors.

First, bone fragments are interdependent data (Grayson 1984:49). Each specimen does not represent an animal - it represents some portion of an animal which may or may not be completely present in the sample. The strict legitimacy of relative measures such as percentages rests on the assumption that each datum in the original data set is independent (Grayson 1984:49).

Interdependence is not a problem if one can assume that each fragment is the only surviving portion of the skeleton from which it came. Several faunal analysts have made this assumption (e.g. Lie 1980; Perkins 1973). It may not be ridiculously far-fetched in some contexts considering the potential impact of taphonomic processes (see Section 5.2.2). Interdependence is potentially relevant, however, in assemblages where notable numbers of articulated bones have been recovered - Robert's Haven (see Section 8.4.4 below), Quoygrew (Colley 1983a:216) and Freswick Links (Jones pers comm.) for example. Even in these cases, however, the importance of using a measure of abundance comparable with fragment count data from other assemblages probably outweighs the potential complications of interdependence.

The interpretation of fragment count data is also complicated by differences in the number of bones between taxa (or body parts). This problem can often be addressed by simple arithmetic (e.g. O'Connor 1989:158). Moreover, it may usually be an insignificant source of error in light of taphonomic background 'noise' (Gautier 1984:245). Unfortunately, however, the problem cannot always be dismissed lightly. For example, very few elements from cartilaginous fishes survive in archaeological contexts (Wheeler & Jones 1989:79-86). Fragment count data for this class cannot be directly compared with other taxa. Furthermore, zooarchaeologists often identify only a selection of robust and diagnostic elements from bony fishes to species (Colley 1990:212; Leach 1986:151-152; Wheeler 1978b:70). It is extremely time-consuming and often impossible to identify elements such as lepidotrich (soft fin rays), pterygiophores, ribs and many skull bones to a meaningful taxonomic category. Different workers have identified different numbers of elements. This inter-analyst variability must usually be taken into consideration when interpreting fragment counts.

It can be addressed in some cases, however, by using class or family (rather than species) level data (see Table 5.1 and Appendix 5.1).

5.2.4 The Weight Method

In this study the weight of excavated bones (where available) is used to evaluate the relative potential meat yield of the animals from which they came. This approach, the *weight method*, is particularly valuable for the comparison of mammal, bird and fish assemblages at the level of class. It has a long history in zooarchaeological investigations (e.g. Cook & Treganza 1956; Davis 1991; Kubasiewicz 1956; Mitchell 1990; Reed 1963; Reichstein 1989; Reitz & Cordier 1983; Reitz et al. 1987). Bone weight data, as unmodified weight measurements or mathematically derived estimates of 'meat' yield, have been used as proxy measures of the *relative potential food yield* of different taxa or groups of taxa. Although approaches to the method vary, all share the assumption that there is a reasonably predictable relationship between the weight (mass) of an animal's skeleton and the quantity of soft tissue, or 'meat', it could have supported (see Barrett 1993). In its various expressions, the weight method has served as a useful supplement to other quantification techniques, such as fragment counts, which serve as proxy measures of animal *abundance*. The discussion to follow (based on Barrett 1994) is intended as a brief review. More detail regarding the use of weight to quantify archaeological bone assemblages can be found in papers by Barrett (1993; 1994) and Mitchell (1990).

Early applications of the weight method assumed, implicitly or explicitly, that there was a roughly linear relationship between the dry weight of an animal's bones and its total or soft tissue weight. If this were the case, a single ratio of bone weight (BW) to total body weight (TW) could describe the relationship. For example, Kubasiewicz (1956:240), followed by Reed (1963:214-215), Ziegler (1973:28) and Reichstein (1989:148) suggested that bone weight constituted approximately 7% of total weight in cattle, sheep and pigs. Cook and Treganza (1956:245) suggested a BW/TW ratio of 6% for mammals and birds and <5% for fish. If such ratios were appropriate, potential 'meat' (total soft tissue) yields could be estimated from archaeological bone weight data by simple arithmetic:

$$MYE = \frac{1}{\%bone/(100 - \%bone)} \times BW \qquad (1)$$

where MYE is the potential meat yield estimate, BW is dry bone weight and *%bone* is the ratio of BW:TW represented as a percentage. This technique might conveniently be labeled the 'single ratio approach'.

Subsequent to the classic weight method studies (Cook & Treganza 1956; Kubasiewicz 1956) empirical explorations in allometry - "the study of size and its consequences" (Gould 1966:587 in Wheeler & Reitz 1987:31) - have revealed that there is actually a *curvilinear* relationship between the weight (mass) of an animal's skeleton and the weight of its total body or soft tissues (e.g. Casteel 1978; Jackson 1989; Prange et al. 1979; Reitz & Cordier 1983; Reitz et al. 1987; Wing & Brown 1979:127-132). Due to physical constraints, the ratio of bone weight to body weight tends to *increase* as an animal grows larger (Schmidt-Nielsen 1984:42-43).

This relationship is usually best described by the power function, which can be written as

$$\log Y = \log a + b(\log X) \tag{2}$$

or

$$Y = aX^b. \tag{3}$$

The independent variable (X) is bone weight or body weight, the dependent variable (Y) is bone weight or body weight, the intercept is a and the slope (also known as the growth ratio) is b (Reitz et al. 1987:305; Schmidt-Nielsen 1984:15; Weatherley & Gill 1987:232). It is possible to calculate an equation for the best-fit line relating bone weight and total weight for a taxon or group of taxa by performing least-squares regression analysis. Bone weight and body weight data derived from reference material are $\log_{10}$ transformed and regressed to produce an equation (resembling 2 above) relating log total weight and log bone weight. By taking the antilogarithm of the intercept, and rearranging the equation into the form of (3) above, the result relates TW and BW in linear units.

Due to the fact that BW:TW increases with animal size, a single ratio is insufficient to describe the relationship and inappropriate as a guide for the interpretation of archaeological bone weight data. This observation has served as the basis of much criticism of traditional weight method techniques (e.g. Casteel 1978; Jackson 1989).

One solution to this problem is to derive the *range* of BW:TW ratios which applies to the range of animal sizes represented in a given archaeological assemblage. This range of ratios could be used *quantitatively* to produce potential 'meat' yield estimates for different taxonomic groups (the range approach). Alternatively, the ratios could be used *qualitatively* as a guide to the interpretation of unmodified bone weight data.

In previous papers, I suggested that this range of ratios be derived using allometric equations relating total weight and bone weight (Barrett 1993; 1994). An example, which derives a range of BW:TW ratios for the sizes of cod family (Gadidae) fishes caught in Viking Age and Late Norse Scotland, is illustrated here. Given the overwhelming dominance of gadoid species in the fish bone collections under study (see Table 5.6) the results for this single family can be used to interpret the fish assemblages as a whole.

First, an allometric equation relating bone weight and total weight in gadoid fishes is derived following the procedures just discussed. Least-squares regression analysis is performed on $\log_{10}$ transformed bone weight and total weight data collected from 91 modern reference skeletons. These included 58 cod, 17 saith, eight ling, five haddock, two pollack and one whiting ranging from 15.5mm to 1.15m in total length and from 36g to 16276g in total weight. The resulting equation (rearranged to relate total weight and bone weight in linear rather than log units) is:

$$BW = 0.01642TW^{1.06524} \qquad (4)$$

(r^2=98.7, p=<0.001) where BW is dry bone weight in grams and TW is total fish weight in grams (Figure 5.2).

A separate regression is not necessary for each species because single allometric equations can adequately describe the relationship between bone weight and total weight in large taxonomic categories. The shrew (*Sorex*) to elephant curve is an example from zoological studies (e.g. Prange et al. 1979), and as Reitz and her colleagues (1987:313) have suggested, "From a biological standpoint, allometry is not only a growth function, but also an evolutionary one. Phyletically close taxa should exhibit similar allometry." The high r^2 and low p values of the current regression support the validity of a single equation for gadoid fishes. This is not to say that species level equations might not be more precise. They would be of little use, however, when used to interpret the weight of all recovered fish bone - much of which might only be identified to the level of class or family (see discussions of diagnostic elements in sections 5.2.3 and 8.3.2).

Second, approximate total weight values must be determined for the smallest and largest gadoid fish likely to be represented in the archaeological assemblages under investigation. These could be based on biological and ecological criteria, or on measurements of archaeological specimens themselves. For example, the largest gadoid fish likely to be caught in north-western European waters is the ling, which might grow to a total length of 1.8m (Muus & Dahlstrøm 1974:114). A fish of this length might weigh approximately 56178g according to a regression formula published by the Department of Agriculture and Fisheries for Scotland, Marine Laboratory, Aberdeen (Coull et al. 1989:28). Similarly, it is perhaps unlikely that gadoid fish of less than 150mm would be routinely caught - an assumption confirmed by measurement of bones from sites such as Robert's Haven where sieving with 1mm mesh was employed (see Figures 5.26-5.50 below). A cod or saith of this length might weigh approximately 47g (Coull et al. 1989:4).

Third, the allometric equation relating bone weight and total weight (equation 4 above) is used to estimate corresponding bone weight values for the lightest and heaviest gadoid fishes likely to be represented in the archaeological assemblages. Each bone weight estimate is then divided by its corresponding total weight to produce a BW:TW ratio.

Following this procedure, the range of bone weight to total weight ratios predicted for cod family fish from 150mm to 1.8m total length is 2.1% (0.99g/47g) to 3.4% (1883g/56178g) (Table 5.3). Moreover, confidence intervals for these ratios can be determined (Table 5.4). The 95% confidence intervals were predicted using the following procedure:

$$\text{Confidence Interval} = 10^{((\log \text{predicted BW} - \log \text{TW}) \pm (2 \times \text{standard deviation of the fit}))}$$

If the same steps are followed (excluding the calculation of confidence intervals, for which original data are needed), using equations relating bone weight and total weight published by Reitz and Cordier (1983:240), a range of ratios can also be derived for the sizes of mammals and birds likely to be represented in the Viking Age and Late Norse middens of northern Scotland. This work has been discussed in a previous paper (Barrett 1993), but the results are included in Table 5.3. Using simple arithmetic, all of these ratios *could* be used to transform the weight of an archaeological bone assemblage into maximum and minimum potential 'meat' yield (total soft tissue) estimates:

$$\text{Maximum MYE} = \frac{1}{\text{minimum } \%bone/(100-\text{minimum } \%bone)} \times \text{BW} \qquad (5)$$

$$\text{Minimum MYE} = \frac{1}{\text{maximum } \%bone/(100-\text{maximum } \%bone)} \times \text{BW} \qquad (6)$$

where (as above) *%bone* represents the BW:TW ratio represented as a percentage. Alternatively, the ratios could be used as a guide for the qualitative comparison of bone weight data.

Before concluding this brief review it is worth considering which procedure is preferable - the range approach or qualitative approach. There are good reasons for using the qualitative approach whenever possible. Fundamental amongst these is the fact that the ratios determined above (presented in Table 5.3) are measures of central tendency in dispersed distributions. They should be interpreted as rough guidelines, not precise constants. Regression analysis, by which the ratios are ultimately derived, is a method of determining the central tendency, or best-fit line, of a distribution. For example, if 95% confidence intervals are determined, the ratio of BW:TW for cod family fishes of 1.8m total length might lie between 3.0% and 3.7%, with a central tendency or best-fit of 3.4% (see Table 5.4). Moreover, the total weight estimates for the smallest and largest gadoid fishes likely to be represented in a Viking Age or Late Norse Scottish assemblage are also measures of central tendency derived using regression equations. The relationship between fish length and weight is reasonably predictable, but will vary to some degree depending on factors such as season of catch (Coull et al. 1989).

This dispersion does not invalidate the weight method. The actual ratio of bone weight to body weight for any *single animal* is likely to deviate to some degree from the predictions in Tables 5.3 and 5.4. However, when used to interpret faunal assemblages which represent *populations of animals* (rather than individuals) these measures of central tendency should resemble reality (see Uerpmann 1973:310). The dispersion *does* mean that the quantitative MYEs of the range approach may imply inappropriate precision.

The precision implied by the ratios presented in Tables 5.3 and 5.4 is also weakened by the fact that it has been necessary to extrapolate beyond the size limits of the data set from which equation (4) was derived (see Schmidt-Nielsen 1984:25). This may be corrected in the future by the collection of more reference material, but it is increasingly difficult to acquire fresh gadoid fish in excess of 1m total length.

A third argument against the range method is the somewhat unpredictable impact of taphonomic processes on bone weight. Taphonomic processes do not invalidate the weight method in total - they affect all methods of faunal quantification and must always be taken into consideration (see Section 5.2.2 above). Relatively speaking, however, the imprecise qualitative approach will probably be less susceptible to bone weight changes than the range approach which actually predicts potential 'meat' yield estimates.

In conclusion, it is possible to suggest that while there is a reasonably predictable relationship between body weight and bone weight for the taxa considered, attempts to produce quantitative 'meat' yield estimates may imply unjustified precision. This is due to dispersion within the bone weight to body weight relationship and to the impact of taphonomic processes. A qualitative approach to the weight method - using established relationships between bone weight and body weight only as general guidelines - may yield more robust (if less precise) results.

For all these reasons, the qualitative approach is employed in this study (see Section 5.6). Unmodified bone weight is used as a proxy measure of the relative potential meat yield of different taxonomic classes. The data are simply qualified to address potential biases introduced by differences in the ratio of bone weight to total body weight for animals of different taxon or size.

5.3 The Faunal and Botanical Assemblages

The archaeological evidence for Norse Orkney, Caithness and Shetland was briefly introduced in Chapter 3 above. Nevertheless, sites for which relevant ecofactual data are available require further consideration given the potential impact of differences in recovery and analytical strategy on palaeoeconomic interpretation. The key characteristics of each faunal and botanical assemblage considered in this study are thus summarised in Tables 5.1-5.2 and discussed in more detail in Appendix 5.1. More lengthy considerations of Earl's Bu, Robert's Haven and Freswick Links - three sites for which some or all data are not available elsewhere - are included below.

The faunal data themselves are presented in Tables 5.5-5.7. For comparative purposes, some taxonomic categories used in the primary sources have been collapsed. Probable identifications, usually represented by adding "cf." or "?" to a taxonomic name, have been grouped with definite identifications of the same animal unless there are no definitive examples of that taxon known from the earldoms. Sheep have been classified as sheep or goat unless a distinction between these two categories has been made explicit. Several categories based on bone size are combined in groups such as large, medium and small mammal. Although these labels are somewhat ambiguous, they reflect animals of approximately cattle, sheep and cat size respectively. Several other taxonomic categories, such as Cetacea (whales), are also simplifications of published records. Shellfish are not included in Tables 5.5-5.7. This is partially because recording methods were more variable than for other taxa and partially because of their low nutritional yield (Evans & Spencer 1976-1977:215-216). They are briefly discussed in Section 5.9 below and (in the context of intra-site patterning) in Chapter 7. Finally, it should be noted that rodent sized specimens were recorded with widely varying degrees of completeness and detail.

Botanical data from Norse sites in Orkney, Caithness and Shetland are presented in Table 5.8. In this case, virtually all taxonomic categories have been retained from the primary reports. Ecological categories are based on the system used by Jacqui Huntley of the University of Durham (Huntley pers comm.). Carbonised 'seeds'* and cereal chaff elements are tabulated by count where possible. In cases where data have been presented in a different form (such as ubiquity, the number of samples in which a taxon occurs [Bond 1994:Appendix A; Pearsall 1989:212]), taxa are recorded as present only. Other carbonised plant tissues (such as wood charcoal) and waterlogged remains are also tabulated as present only.

5.3.1 Earl's Bu, Mainland, Orkney

Earl's Bu, on the south coast of Mainland at Orphir, is c.200m from the shore of Scapa Flow. Excavations directed by Colleen Batey and Christopher Morris between 1979 and 1993 focused on a horizontal water mill and on middens which overlay and infilled the mill chamber (Batey 1993a; Batey & Morris 1992). The latter were particularly rich in ecofactual remains, but some faunal and botanical material was also recovered from structural features of the mill and from contexts* which predate it. The site is in a relatively fertile area of noncalcareous gleys, brown forest soils and brown rankers (Macaulay Institute for Soil Research 1982b; 1983b). Although not on soils derived from calcareous sand (where most faunal assemblages from the earldoms have been located) the pH is relatively high, facilitating adequate bone preservation (Appendix 5.2; Linse 1992:328).

Radiocarbon dates are not yet available for Earl's Bu. Nevertheless, artifacts and stratigraphy provide an approximate chronological framework. Viking Age contexts predating and contemporary with the mill held steatite vessel sherds and are tentatively dated to c. 950-1050 (Phases M, N, O, P, Q, R) (Batey pers comm.). Late Norse middens overlying the structure (Phases T, U, V, X) included steatite, a runic inscription on bone, an iron key and glazed pottery which suggest a date range between the 12th and 14th centuries (Batey pers comm.; see Appendix 5.3).

The substantial ecofactual assemblage from Earl's Bu was recovered by flotation of 18864 litres of sediment (excluding 46 samples which were not measured) using 1mm mesh to collect the heavy fraction and 0.5mm mesh to retain light botanical remains. Note that the volume of 125 samples for which this measure was not recorded has

* The term 'seed' is used in a general sense to refer to all disseminules.
* "Context" is used (in this case and hereafter) to refer to a discrete stratigraphic unit, or layer, recognised during excavation. At Earl's Bu, Robert's Haven and Freswick, contexts were subdivided into one or more "samples" of sediment which were processed for recovery of ecofacts. Each context and sample received a unique identification number.

been estimated from sediment weight by regression analysis. Details are given in Appendix 5.4.

The ecofactual material is still under study by Jacqui Huntley (botanical macrofossils), Ingrid Mainland (mammal and bird bone) and the author (fish bone). However, it has proven possible to complete the analysis of bone from a selection of upper strata. Although subject to the caveats raised above, these can be tentatively dated as Late Norse, probably largely LN2, based on stratigraphic and archaeological evidence. They were chosen to provide an assemblage of probable domestic origin for comparison with deposits from Area A at Robert's Haven which may derive from cured fish production (see Section 5.3.2 and Chapter 7 below).

The contexts for which bone has been analysed were chosen by the author based on preliminary stratigraphic information provided by the excavators. After the relevant assemblages had been studied, however, the final sequence of phasing became available. Appendix 5.3 thus illustrates the relationship between the contexts considered in this study and the excavator's final phasing scheme.

A preliminary report on botanical samples from Earl's Bu was completed prior to the availability of any phasing information (Huntley 1990). However, 12 of the 18 stratigraphic contexts examined derive from Late Norse filling of the mill chamber. Only data from these 12 layers are included in Table 5.8 (see Appendix 5.3). Although broadly contemporary with the analysed faunal material, the preliminary botanical data are not from precisely the same group of contexts. Quantitative comparisons between the bone and seed assemblages are therefore not yet possible.

As mentioned above, bones were recovered by water sieving using 1 mm mesh in modified Siraf tanks (Wheeler & Jones 1989:51-53). However, the precise recovery strategy varied during the 14 years (1979-1993) over which fieldwork was conducted. It should be noted that the staff of the project - many of whom were student volunteers who cannot now be contacted - varied throughout this period. Moreover, excavation spanned the decade during which ecofactual sampling first became a standard procedure of archaeological recovery on British medieval sites. Problems of omission, data loss and uncertainty encountered during the author's attempt to collate over 2776 individual records regarding 595 samples should thus be viewed in proper perspective.

Adequate information is not available regarding sampling procedures in 1979 and 1980. Bone recovered during these field seasons is thus omitted from the present analysis. In 1990 and 1993 sediment was judgmentally sampled for sieving based on a philosophy of 'total' recovery. At least one bucket (c.14 litres) of soil was sieved from most contexts. If it revealed bones or seeds, virtually the entire context would be processed. Sampling was not continued for sterile contexts.

Contrary to previous assumptions (Barrett 1993:3), however, all layers were not sampled in this way during earlier field seasons (1985, 1986, 1988, 1989). Study of field notebooks and the relative weight of sampled and hand collected bone reveals that some contexts were only partially sieved, with bone being collected by hand from both the sieved and unsieved portions. No record was kept of what hand collected bone came from sediment which was and was not subsequently sieved. This procedure presents a problem of interpretation. If hand collected material is not considered, larger taxa will be underestimated (as bones were removed from sampled sediment prior to sieving). Conversely, if both sieved and unsieved fractions are combined, smaller taxa (particularly fish) will be biased against (see Section 5.2.2 above).

The latter bias may be more acceptable than the former, particularly as many comparative assemblages from the earldoms were only partially sieved (Table 5.1). However, given that Earl's Bu provides a site which was *almost* sieved in its entirety, it seems worthwhile to attempt another approach. Thus, this study only includes data from contexts for which $\leq$ c.10% of the total weight of bone was hand collected. In these cases I assume that a layer was probably entirely sieved while a few bones were incidentally hand collected with artifacts.

Subsequent to field processing, the heavy fraction of each sample was re-sieved using 4mm mesh and sorted into material categories under the supervision of (sequentially) Jacqui Huntley, Christopher Morris and the author. The quantitative data included in Tables 5.5-5.7 are based on bone from this fraction. The <4mm sample material was then divided into two groups by cursory examination: samples with and without rodent sized mammals or fish. If either category was present, the sample was selectively sorted for tiny mammal bones (principally mandibles, maxillae and long bones) and three fish elements (dentaries, premaxillae and vertebrae).* The latter, which provide an indication of the taxa and sizes of fish lost through the 4mm mesh, are presented in Table 8.23. Species represented in the <4mm size fraction which did not occur in the >4mm material are noted as present in Table 5.6. Rodent size mammal bones from the <4mm fraction remain to be analysed.

It was originally hoped to use weight data collected during the sorting of materials from the >4mm sample fraction for the examination of intra-site patterning. However, on collation of data accumulated under variable conditions over more than a decade

---

* Otoliths were also sought during sorting of the <4mm sample fraction, but none have survived at Earl's Bu.

information regarding 241 of 595 samples was missing or ambiguous. Thus, only weight data collected during specialist analyses of bone and shell from the LN2 contexts mentioned above are recorded in Appendix 7.2 and discussed in Section 5.6 and Chapter 7 below.

Mammal and bird specimens were identified to the finest possible anatomical and taxonomic level (Mainland 1993; 1994; n.d.). To provide a strictly comparable 'control assemblage', the fish bone from Earl's Bu was analysed following the strategy developed for Robert's Haven (described in detail in Section 8.3.2 below). In essence, it involves identification of nine elements (belonging to quantification category 1, or *Q1*) to the smallest possible taxonomic level while other bones are less precisely identified. In Table 5.6, these nine diagnostic elements are tabulated by family, genus or species while other bones are simply categorised as gadoid or not gadoid in origin and combined in the groups *Q2* (vertebrae), *Q3* (30 cranial and pectoral bones identified to element but not species) and *unidentified.*

This method has two advantages. First, the relative abundance of different fish species is directly comparable using Q1 elements. Second, the table sum (which represents all fish specimens from the >4mm sample fraction) can be directly compared with the mammal and bird assemblages. More detailed records of the fish assemblage, which also include bones from several contexts for which mammal and bird data are not yet available, are presented in Tables 8.22-8.31 (see Section 8.5).

The Earl's Bu data presented here, and interpretations based on them, are partial and preliminary. Final assessment of the site must wait until the substantial ecofactual assemblage is completely analysed. Nevertheless, information currently available from the latest Norse strata provide a useful addition to the modest corpus of Orcadian sites for which faunal and floral data exist.

5.3.2 Robert's Haven, Caithness

Robert's Haven lies in a small bay of the same name facing northwest onto the Pentland Firth near John O' Groats, Caithness. The archaeological features accumulated in calcareous wind-blown sands at the eastern extremity of a region of relatively fertile noncalcareous gleys. The fertility of the area, an agricultural estate in the 18th century (Matheson 1817; see Plate 2.1) and probably in the Late Norse Period (Pálsson & Edwards 1981:101, 124, 145, 150), is underscored by the intractable surrounding landscape of blanket peat (Macaulay Institute for Soil Research 1982a).

The site was chosen by the author as the focus of a project to investigate the possibility that the Norse earldoms of Orkney and Caithness were involved in the production of cured fish for export. In the Spring of 1992 survey confirmed earlier reports (Batey 1984:24-25) that middens dominated by well preserved fish bone and tentatively dated to the Late Norse Period were eroding into the sea. Fieldwork directed by the author subsequently progressed in two parallel phases. The first employed aerial photographs, visual survey of the eroding wave cut bank, auger survey along transects running inland from the shore, and geophysical survey using a fluxgate gradiometer and an electrical resistivity meter (Barrett 1992b; 1992c; Johnson 1993; Morris et al. 1994). In total, this work revealed three areas of surviving archaeology in a landscape which was otherwise denuded by extensive sand quarrying in the middle years of the 20th century (see Figure 5.4). These areas, designated A, B and E (Areas C and D included only modern and natural deposits), formed the focus of the second phase - small scale excavation.

Area A included c.28m of midden (reaching a maximum thickness of c.1.3m) exposed in the wave cut bank (Figure 5.5). It has been described as a 'fish midden' based on the marked dominance of fish bone and marine mollusc shell in the entire exposed face of the deposit (see Section 7.2). Three sample columns 50cm x c.75cm in dimension were excavated (Figure 5.7). They were spaced as evenly along the exposed cliff face as its unstable topography allowed. Accelerator Mass Spectrometry (AMS) assays of carbonised barley from upper and lower strata provided calibrated dates of A.D. 1288-1412 and A.D. 1172-1266 respectively (1 sigma, calibrated age ranges for Robert's Haven are based on the University of Washington, Quaternary Isotope Laboratory, Radiocarbon Dating Programme, 1987). These results are consistent with the recovery of three sherds of Scottish east coast white gritty type ware pottery of 13th-14th century origin (Will 1995). Area A can thus be dated to LN2, Phase 1 in the sequence of activity at Robert's Haven (see Table 5.9).

Fragmentary structural remains and middens less rich in fish bone c.25m north along the shore comprised Area B (see Figures 5.5, 5.8 and 5.10). Two columns 50cm x c.75cm in dimension were excavated here. The lowermost midden strata are broadly contemporary with Area A (and thus also Phase 1). An AMS assay of carbonised barley from context 7022 yielded a calibrated age range of AD 1280-1394 (1 sigma). The uppermost deposits of this area - middens and associated structural remains grouped as Phase 3 - are somewhat more recent. Barley from context 7005 dates to AD 1489-1649 (1 sigma). The intervening strata, marked off to some degree by presumed natural sand accumulations potentially indicative of a hiatus in occupation, are classified as Phase 2. These are tentatively interpreted as LN2 in date, but further ^{14}C determinations would be useful.

Area E included midden strata in the immediate vicinity of a ruinous structure c.150m inland (see Figures 5.6, 5.9 and 5.11). Quarrying in this area had ceased on discovery of the building (M. Sinclair, Keiss, Caithness, pers comm.). A single sample column of $1m^2$ (E) was excavated to recover midden material and a test pit of the same dimensions (I) was opened adjacent to the structure to examine stratigraphic relationships. No radiocarbon dates are available for the area. However, two pottery sherds (one each of Scottish medieval redware and Scottish east coast white gritty type ware) tentatively suggest that the primary midden layers are broadly contemporary with LN2 (Phase 1) deposits on the shore. Other phases in Area E include natural subsoil (Phase 0), modern landscaping activity (Phase 4) and the structure.

The date of the latter is somewhat uncertain. It immediately overlies the presumed LN2 strata of Phase 1 and was only discovered during sand quarrying in the 1940's (M. Sinclair, Keiss, Caithness, pers comm.). It is c.9m x 6m in dimension and built with uncut stone using mortar derived from calcareous sands. Although this technique cannot be closely dated, it is not inconsistent with a Late Norse origin. Similar building methods were observed by the author at Forse Castle, a 12th or 13th century construction (Gifford 1992:117). The function of the structure is uncertain, but a possible secondary staircase in the south corner implies that it may once have had more than one story (Figure 5.6; see also Batey 1984:59). If so, it may well have been a building of some visual impact (if less striking than the potentially contemporary castles of Caithness and Orkney). However, several sections of poorly rebuilt wall suggest that its final function may have been less salubrious.

As a palaeoeconomic investigation, in which the study of ecofacts was to be a key concern, all excavated sediment from the sample columns was wet-sieved to 1mm (heavy fraction) and 0.5mm (floating fraction) using a modified Siraf tank (Wheeler & Jones 1989:51-57). The heavy material was subsequently re-sieved to greater and less than 4mm in the laboratory and only the >4mm fraction comprehensively sorted for all cultural remains. As with the Earl's Bu assemblage, only microfauna (principally rodent bones) and selected fish bones (to control for the loss of small individuals and elements) were collected from the <4mm fraction (see Section 8.3.2). In sum, 118 samples totaling 3334.1kg and 2842.5 litres (wet weight and volume) were processed. A breakdown of this total by area is given in Table 5.10.

Further small samples were taken for soil study. Approximately 1 litre of sediment from virtually every context was collected for the investigation of organic content, phosphate content and pH. To date, only the latter has been determined. Results are tabulated in Appendix 5.2 and briefly discussed in Section 7.2 below. In addition, three undisturbed, representative, soil micromorphology samples were collected (in 8cm x 5cm Kubiena tins) from both Column C, Area A, and Column G, Area B. The results of this work are reported elsewhere (Simpson & Barrett forthcoming) and incorporated in Chapter 7 below.

The Robert's Haven project is ongoing. Nevertheless, results of most specialist analyses are available for Area A (which yielded the largest faunal and botanical assemblages). Botanical data from Area B are also available, but are only considered in Chapter 7 below to ensure that results regarding Robert's Haven in Tables 5.5, 5.6, 5.7 and 5.8 reflect the same archaeological deposits. Mammal bone has been identified by Ingrid Mainland (pers comm.), bird bone by Tanya O'Sullivan (pers comm.), botanical macrofossils by Jacqui Huntley and Susan White (pers comm.), terrestrial molluscs by Judith Turner and Terry O'Connor (pers comm.) and fish bone by the author (see Chapter 8). Given the purpose of the Robert's Haven project - to investigate the possibility that cod family fish were being processed for export - the small number of specimens from non-gadoid taxa have not yet been fully analysed. These will ultimately be published as part of a site report currently in preparation.

The quantitative data in Table 5.6 (and Figures 5.20-5.25) are based on bone from the >4mm sample fraction. However, fish taxa found only in the <4mm fraction are indicated as present. They are also reported in Chapter 8 below where the fish assemblage from Robert's Haven is discussed in detail. The methods used for analysis of bones from this site are (with the exception of non-gadoid fish taxa) identical to those described for Earl's Bu.

5.3.3 Freswick Links, Caithness

Investigations at Freswick Links, under the aegis of the Viking and Early Settlement Archaeological Research Project (VESARP), focused on Pictish, Late Norse and possible Viking Age deposits spread along a bay of the same name in northeastern Caithness (Batey 1989b; Jones et al. 1983; Jones 1991a; Jones 1991b; Morris et al. 1992:97; Morris et al. forthcoming a; Rackham et al. 1984; see Figure 5.12). Like Robert's Haven, the site lies on a coastal strip of calcareous blown sands in a lowland area otherwise dominated by relatively fertile noncalcareous gleys (Macaulay Institute for Soil Research 1982a; 1983a; Ritchie & Mather 1970; see also Plate 2.1).

The 14 excavation areas can, for present purposes, be combined into five sites: the Northern Cliff Areas (Areas 4, 5, 6 and 10), the Middle Cliff Areas (Areas 7 and 8), the Southern Cliff Areas (Areas 11, 12, 13 and 14), Area 9 and Area 3. These are abbreviated hereafter as NCA, MCA, SCA, A9 and A3 respectively. Excavations of

Area 2 are not yet complete and Area 1 is essentially pre-Norse in date (Morris et al. forthcoming a).

Justification for these combinations lies in gross compositional and/or stratigraphic similarities within each group (Morris et al. forthcoming a). Figures 5.13-5.18, compiled from data included in the forthcoming Freswick Links report, illustrate the relevant feature types, stratigraphic relationships and dating evidence (Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris forthcoming b; forthcoming c; Morris & Cook forthcoming; Rains & Morris forthcoming). The excavators' original phase and dating interpretations have been condensed (and in a few instances reinterpreted) to make them consistent with the chronological framework of the present study (the *Periods* of Figures 5.13-5.18). The two Middle Cliff Areas (Figures 5.14-5.15) cannot be linked stratigraphically. Nevertheless, their spatial association, dating evidence and archaeological character has led the excavators to interpret them as a single unit (Rains & Morris forthcoming).

Complexity surrounding the dating of Freswick has been introduced in Section 3.5 above. The first concern, poor representation of Viking Age deposits in the VESARP excavations, is probably a sampling issue. It is simplified if the recent excavations are kept conceptually distinct from past surface finds and early 20th century work. Substantial Viking Age settlement at Freswick, from which 10th century artifacts collected in the past must have derived (see Batey 1987a), was probably simply outwith the recent excavation areas (and may well be completely destroyed by marine erosion, see Morris et al. forthcoming a).

The second issue involves inconsistencies between radiocarbon assays on cereal grain and other dating evidence - artifacts, radiocarbon assays on bone and thermoluminescence determinations on pottery. In Area 5 of NCA and Area 8 of MCA cereal grain yielded dates of Pictish age while other evidence was strongly indicative of the Late Norse Period (see Figures 5.13 and 5.15). The simplest explanation is probably that the cereal was residual (Morris et al. forthcoming b). It should thus be kept in mind that some other ecofacts from NCA and MCA could also be redeposited from earlier layers. This issue is discussed in more detail in Chapter 7 below.

A third dating complication is created by summary of species identification data regarding mammal, bird and botanical assemblages by area rather than phase (Allison forthcoming b; Gidney forthcoming; Hibberd forthcoming; Huntley & Turner forthcoming; Nye forthcoming). This is not a major problem, however, because spatial and chronological patterns at Freswick Links are broadly parallel. Thus, the majority of bones and artifacts from NCA derive from Late Norse 2 middens (Figure 5.13), *most* cultural materials from MCA are probably Late Norse in date (Figures 5.14-5.15) and *most* bones and seeds from SCA are likely to be Pictish in origin (Figure 5.16). The lack of phasing in A3 and A9 is irrelevant as both are composed of mixed or broadly dated material (Figures 5.17-5.18).

The legitimacy of these broad generalisations can be tested by recourse to an independent data set - the weight of shell and bone recovered from each sample during initial sorting. Although this information is not without its own complexities (see below), it *has* been tabulated by phase and grouped into the chronological periods used in this study. Table 5.11 records the weight of ecofacts recovered in each period of NCA, MCA and SCA. It is evident that, at a very general level, the combined data from each site conform to the chronological pattern just outlined.

A fourth and final complexity regarding dating applies exclusively to fish bones (Jones 1991a; Jones et al. forthcoming b). They are not comprehensively tabulated by area *or* phase. Data exist for the entire assemblage, without spatial or chronological resolution (Jones 1991a:246-248; Jones et al. forthcoming b), and for selected areas (or portions of areas). The latter include Area 3, Area 4, Area 9 and the 'Pictish' contexts of Areas 11-14 (as a single unit) (Jones 1991a:253-254, 270-271, 275-277, 280-281; Jones et al. forthcoming b).

In summation, complications regarding dating at Freswick Links are not equally problematic. Chronological differences between artifacts recovered during recent and past excavations are easily explained. The tabulation of mammal, bird and botanical data by area is similarly acceptable. However, the impact of residuality (specifically of cereal grain) on the palaeoeconomic interpretation of NCA and MCA is difficult to assess. The botanical assemblage from Freswick Links will thus be considered rather cautiously. Moreover, inconsistent reportage of the fish bone assemblage makes it impossible to conduct useful inter-class comparisons of bone abundance (a problem which is acerbated by recovery and analytical strategies discussed below).

The recovery strategy at Freswick Links involved both hand collecting and sieving using a modified Siraf tank (although a small number of samples from Area 10 were dry sieved) (Jones et al. forthcoming a; Wheeler & Jones 1989:51-57). The sieved fraction included all sediment from designated portions of each area - typically central 4m x 0.5m strips within excavation trenches of 4m x 2m (Jones et al. forthcoming a). In areas such as 7 and 8 (MCA), however, the discovery of structural remains led to expansion of the excavation trenches and a more judgmental sampling strategy (Jones et al. forthcoming a). In all cases 1mm mesh was used to recover the residue (heavy fraction) - primarily bone and shell - while floating botanical remains were caught on

0.5mm mesh (Jones et al. forthcoming a; Huntley & Turner forthcoming). A total of 29412 litres of sediment was sieved (excluding 39 samples for which the quantity of sediment is unknown): 6550 litres from NCA, 7837 litres from MCA, 8637 litres from SCA, 5029 litres from A3 and 1359 litres from A9 (unless otherwise indicated, sample data has been tabulated by the author based on Freswick archive data). Note that the volume of 38 samples for which this measure was not recorded has been estimated from sediment weight by regression analysis. Details are given in Appendix 5.4.

The strategy used to sort the resulting sample residues deserves special attention. Virtually all mammal and bird bone was sorted from the samples (Jones et al. forthcoming a; see Table 5.12). However, given the enormous time taken to separate all fish bone and shell fragments recovered by 1mm mesh (see Jones 1991a:51-52), it was decided to select only a set of identifiable specimens from the residues. For shell, dominated by limpets, this entailed complete shells and apices (Jones et al. forthcoming). For fish,

> although a wide range of bones was collected from the washed and dried sample residues by the team of sorters, the following bones were selected for detailed recording: otoliths, premaxillae, dentaries and cleithra for cod, ling, saithe, pollack and haddock. All bones of other species (with the exception of small (300 mm total length) gadid vertebrae) were collected and identified (Jones et al. forthcoming a).

It is also evident from Jones' (1991a:309) tables that some elements with obvious butchery marks were also selected for identification.

The effect of these procedures on bone counts *within each class* are likely to be consistent and small - with the caveat that the main gadoids will be underestimated *vis-à-vis* other fish taxa unless comparisons are restricted to one or more of Jones' four diagnostic elements. However, the impact on inter-class comparisons will inevitably be enormous. Virtually all bird and mammal specimens are quantified while only a few elements have been identified for most of the fish assemblage.

The implications of this sorting strategy for comparisons using shell and bone weight are also notable. Figure 5.19 and Table 5.12 compare the relative weight of shell, fish bone, mammal bone and bird bone from 47 samples (all from Area 4 of NCA) when:

1) sorted according to Jones' strategy and

2) sorted completely to >4mm.

The latter data were collected by using 4mm mesh to sieve residues which remained after Jones' initial sorting, completely resorting the >4mm fraction, collecting the weight of each class of material and summing these values with the initial sorting data. This comparison is not ideal, as the 'complete' sorting data may be slightly biased. They may exaggerate the difference between the two assemblages as some specimens which would have passed through the 4mm mesh may have been collected during Jones' initial sorting. Moreover, the resorted residues are those few which had escaped discard. They are all from Late Norse 2 (43 samples) and hiatus (4 samples) Periods of NCA and do not represent systematic or random coverage of the feature types excavated at Freswick.

Despite these caveats, Figure 5.19 and Table 5.12 provide a clear warning that fragment count and weight data from Freswick Links cannot be used for absolute inter-class comparisons. Fish and shell are both significantly underestimated by the initial sorting strategy (at the 99% confidence level based on Mann-Whitney one-tailed tests). As the same sorting strategy applied over the entire site, however, it may be valid to use these data as an indication of *relative* differences between phases and excavation areas. This is attempted in Chapter 7 below. Limited comparisons of absolute bone weight at the class level are also possible using data from the 47 resorted samples (see Section 5.6).

Given that the sorting strategy invalidates inter-class comparisons of bone abundance, sieved and unsieved portions of the mammal and bird assemblages are combined in Tables 5.5 and 5.7. Although this procedure may have some impact on the abundance of smaller taxa, recovery bias is unlikely to effect these classes as severely as fish (see Section 5.2.2 above). Only sieved material is tabulated for the latter assemblage (Jones pers comm.).

5.4 Arable Agriculture.

Having introduced the available evidence (in Chapter 3, Section 5.3 and Appendix 5.1), it is possible to attempt a broad reconstruction of subsistence activities in the Norse earldoms. There can be little doubt that arable agriculture, particularly cultivation of barley and oats, played a significant role in both the Viking Age and the Late Norse Period. The suitability of Orkney, Caithness and (to a lesser degree) Shetland for cereal cultivation under modern environmental conditions is illustrated by *Land Capability for Agriculture* maps of the Macaulay Institute for Soil Research (1983a; 1983b; see Figure 2.3). It is probably not coincidental that virtually all of the sites considered in this study lie on or adjacent to the best agricultural soils of the earldoms (compare Figures 1.2 and 2.3). Moreover, the origin of anthropogenic deep topsoils in Orkney may date to the Late Norse Period (Simpson 1993:8).

Even during the presumably colder years of the Little Ice Age (Grove 1988), Caithness and Orkney exported grain and were described as fertile by contemporary observers (e.g. Brand 1883[1701]:45, 110-111, 225; Low 1879[1774]:161; Martin 1981[1716]:353-357; Mitchell 1906:169; Pennant 1979[1774]:182; Pope 1979[1774]:328; Sibbald 1845[1711]:6-8; Withrington & Grant 1979[1791-1799]:250). Accounts which pre-date the landscape changes of early modern agricultural improvement, predominantly a late 18th to early 19th century phenomenon in the north of Scotland (Miller 1989b:91-103; Thomson 1987:199-206), are particularly relevant. Sibbald's (Sibbald 1845[1711]:6-8) account of 1711, incorporating Monteith's early 17th century description of Orkney, describes Sanday, North Ronaldsay, Westray and Papa Westray as "very fertile" in barley and oats. Pennant (1979[1774]:328) describes Caithness as "a flat plain country, having few hills; the soil good, and producing great quantities of corn in fruitful seasons" in 1769. Local contributions to the *Statistical Account of Scotland* describe Caithness and Orkney as fertile and productive of barley (Withrington & Grant 1978[1791-1799]:10, 120; Withrington & Grant 1979[1791-1799]:250). Even in Shetland, in Unst for example, enough cereal was grown to support local needs in good years in the late 18th century (Low 1879[1774]:161). In "ordinary" years, however, much grain had to be imported (Low 1879[1774]:141, 161).

Regarding Caithness, the *Military Survey of Scotland 1747-1755* (also known as Roy's Map) provides a particularly vivid, if somewhat stylised, depiction of the extent of arable agriculture (O'Dell 1953; Whittington 1986:20, 25-27). Figure 2.4 shows the extent of cultivated land represented in the whole of northern Scotland (after O'Dell 1953:60) while Plate 2.1 provides an example of the original (the fair copy), illustrating the Duncansby area of Caithness.

Literary and historical evidence implying the production of grain during (and immediately following) the Late Norse Period in Orkney, Caithness and Shetland is available from 12th-13th century saga accounts (McGrew 1970:130; Pálsson & Edwards 1981:70, 105, 163; Porter 1994:110), an early 15th century "Complaint of the people of Orkney about the misrule of David Menzies of Weem" (Clouston 1914:36), and 15th-16th century rentals (Andersen 1989:21-22; Peterkin 1820; Thomson 1987:116, 119-120). It is also conceivable that King Sverrir's speech of 1186 -in which he thanked Orcadians, Shetlanders and others for "such things as make this land [Norway] the richer, and we cannot do without" (Sephton 1899:129) - referred in part to grain (Thomson 1987:110; see Section 6.8.4 below).

Structural and artifactual evidence is also suggestive. Late Norse grain drying kilns have been recognised at the Beachview Studio Site (Morris forthcoming a), Jarlshof (Hamilton 1956:190-192) and Freswick Links (Batey 1987a:97). Moreover, cereal agriculture is at least implied by the presence of quern stones in Norse contexts such as Saevar Howe, Earls Bu and Freswick Links (Batey 1987a:162-163; Batey & Morris 1991:45; Hedges 1983:85). Miniature, perhaps toy, rotary querns were found in Viking Age and Late Norse contexts at Sandwick, Underhoull and Jarlshof in Shetland (Bigelow 1985:119; Hamilton 1956:149-150, 182; Small 1966:244-245; see Section 3.5 above regarding the dating of Underhoull). Perhaps grain processing played an important role in the symbolic activity of socialising children. The potential symbolic importance of cereal agriculture is also underscored by the recovery of sickles in at least nine Viking Age graves from Orkney and Caithness (see Appendix 3.3).

Perhaps the best evidence for large-scale cereal production in Orkney is the horizontal water mill excavated at Earl's Bu (Batey 1993a; Batey & Morris 1992). Although it is the only known example of Norse date in the earldoms, historical records from following centuries suggest that they may have been ubiquitous. Mills are mentioned in a rental document of 1492 and in 1575 there were 28 on the island of Mainland, Orkney, alone (Fenton 1978:397). John Hunter (1991) has noted that horizontal mills have been associated with small scale peasant farming (see also Batey 1993a:24). It should be noted, however, that their recent role existed in opposition to modern mills with vertical wheels, rather than the hand quern. As the latter would appear to have been the Viking Age and Late Norse alternative to horizontal mills, the site at Earl's Bu may well represent cultivation on a substantial scale.

The archaeobotanical record provides the most concrete evidence for arable agriculture in both the Viking Age and Late Norse Period. The cultivation of barley, oats and flax was probably of primary importance, although some gardening of taxa such as the Celtic bean (*Vicia faba*), vetch (*Vicia*), wild radish (*Raphanus raphanistrum*) and cabbage or kail (*Brassica*) may also have occurred (see Table 5.8; Andrew 1994:105-114; Huntley & Turner forthcoming; Rackham forthcoming). Barley occurs in 20 of the 24 botanical assemblages considered in this study. It is only absent from sites where no attempt was made to recover grain and seeds. Oats, present in 19 assemblages, are similarly ubiquitous. They are missing from the same sites as barley, with the addition of The Biggings, where only small samples of waterlogged material were collected. Flax, present in 14 assemblages, is almost as ubiquitous but represented by much smaller seed counts (Table 5.8; see also Bond & Hunter 1987). It could be used for oil, fiber, food or animal fodder (Nye & Boardman n.d.; Bond & Hunter 1987). Combining the Viking Age and Late Norse evidence summarised in

Table 5.8, these three taxa constitute 67.8% (18868 disseminules) of the carbonised specimens recovered (omitting sites where full quantitative data are not available). In no case do they drop below 33.8% of a single carbonised botanical assemblage, and usually constitute much more. There is little evidence that this broad pattern changed over time (Figure 5.20). As Julie Bond (1994) has found at Pool, however, the ratio of oats to barley may increase from the Viking Age to the Late Norse Period. This trend is not universal - inter-site variability is evident in all periods - but Late Norse assemblages such as Earl's Bu and Beachview Burnside Area 2 have produced considerably higher proportions of oats than Viking Age examples such as Saevar Howe and Brough Road Area 2 (Figure 5.20).

The recovery of chaff - rachis internodes, culm nodes, awns, lemmas, glumes and oat floret bases - and taxa associated with agricultural fields - such as corn spurrey, chickweed and knotgrass - suggests that at least some of the cereal grain was grown locally (Table 5.8; see Hillman 1984; Hinton 1990). The very fact that so much carbonised grain has been recovered could be interpreted in this light (Bigelow 1985:119). Based on ethnohistoric analogy (Fenton 1978:375-395), barley and oats were probably carbonised during drying shortly after harvest. Only a few grains of wheat from Freswick Links, Earl's Bu and Robert's Haven could be argued to represent imported cereal (Huntley 1990; pers comm.; Huntley & Turner forthcoming). Wheat cannot now be successfully grown in the earldoms (Coppock 1976). Even in this case, however, the 31 recovered grains could represent contamination of other cereal crops or a small scale attempt to grow wheat locally (Huntley & Turner forthcoming). The latter possibilities may be supported by recovery of 5 wheat rachis internodes at Freswick Links. The grain from Freswick and Robert's Haven was free threshing bread wheat, for which chaff might be expected to remain at the processing site (Hillman 1984). The Celtic bean, represented by two specimens at Freswick Links and one at Earl's Bu, could conceivably also represent an import (Bond pers comm.). Beans are not grown as far north as Caithness in Scotland today (Coppock 1976:73).

Arable agriculture was obviously a ubiquitous source of wealth in the earldoms. However, the issue of drying raises a caveat regarding the apparent dominance of cereal grain in the carbonised botanical assemblages. Unlike other economic plants (collected or cultivated for food or fibre, see Andrew 1994:105-129), barley and oats were routinely exposed to fire. In early modern Orkney, grain was dried in household kilns or in pots over a hearth (Fenton 1978:375-387). As mentioned above, archaeological examples of Late Norse kilns have been tentatively identified in Orkney, Caithness and Shetland. Historical accounts mention the danger of fire in kilns (Fenton 1978:377). One traditional Orcadian dish, Burstin, involved roasting whole grain - usually leaving some burnt (Fenton 1978:375, 395). Grain is almost certain to have an exaggerated presence in the archaeological record.

Another cautionary tale regarding the potential scale of arable agriculture comes from palynological analysis of a peat core from the Hill of Harley, near Freswick (Huntley 1994; forthcoming). Barley-type pollen disappears from the core at the onset of the Viking Age. It is possible that the extent of cultivation was reduced after Norse colonisation of the area. Given the limited dispersal of cereal pollen, however, this evidence could simply indicate a minor change in field location (Huntley 1994:540; forthcoming).

In summation, it would appear that arable agriculture (particularly cereal cultivation) was a possible, widespread and symbolically important source of wealth from the Viking Age to beyond the terminus of the Late Norse Period. Post-medieval and early modern evidence indicates that the quantity of grain produced could meet local need and supply a surplus for export. As discussed further in Chapter 6, however, this pattern is linked to years with good harvests (particularly in Shetland, but also in Orkney and Caithness). Grain shortages were recorded as a common event in the post-medieval period (Fenton 1978:332-333, 337). For example, "the North Ronaldsay folk had barley bread in winter only in 1529, with fish and milk as the summer substitutes" (Fenton 1978:332). These post-Late Norse shortages can probably be attributed at least in part to the Little Ice Age (see Section 2.6 above). Nevertheless, the exposed location of most agricultural land in the earldoms must always have bared crops to the danger of periodically devastating weather events (see Section 6.9 below). The systematic exposure of grain to conditions conducive to preservation by carbonisation may thus overestimate its quantitative importance in the subsistence economy of the Viking Age and Late Norse earldoms. Given the presence of sickles in Viking Age graves and 'toy' quern stones in Viking Age and Late Norse domestic assemblages, however, the *qualitative* importance of cereals is probably unquestionable.

5.5 Pastoralism

Currently, much of the landscape of Orkney, Caithness and Shetland is best suited to grazing or fodder production (see Section 2.3 and Figure 2.3). Although much potential agricultural land has been turned over to pasture in recent centuries (compare Figures 2.3 and 2.4), the environmental potential for keeping domestic livestock must have been considerable in the Viking Age and Late Norse earldoms. Historical, linguistic and archaeological evidence indicates that this potential was exploited for the keeping of cattle, sheep, pigs, a few goats and horses. Dogs and cats complete the domestic fauna of the earldoms.

Onomastic evidence for pastoralism during the period of Norse speech in Orkney, Caithness and Shetland derives from the distribution of the place-names *sætr* and *ærgi* (Fellows-Jensen 1984:160-163; see Figure 4.3). These have been interpreted as the names of shielings - summer pastures for cattle and sheep which are known from Viking Age and medieval contexts elsewhere in Scandinavia (e.g. Mahler 1991; Sveinbjarnardóttir 1991). Most of these place names cannot be closely dated, but excavated medieval shielings are now known from Skye in the Hebrides (Miket pers comm.). Moreover, shieling names (such as *Ásgrímsærgin*, where Þorbjǫrn Klerkr, the killer of Earl Rǫgnvaldr Kali Kolsson met his end) do occur in *Orkneyinga Saga* (Guðmundsson 1965:281-282).

The keeping of cattle and "animals" is also noted in *Orkneyinga Saga* (Pálsson & Edwards 1981:163, 194). Moreover, Alexander III fined the people of Caithness 200 head of cattle in 1264 (in retaliation for their enforced support of Hákon Hákonarson's campaign in Scotland) (Crawford 1985b:38). Zooarchaeological evidence indicates that cattle, sheep, pigs, horses and a few goats (which are often difficult to distinguish from sheep in archaeological material) were kept during all periods under study, with little chronological change in their relative abundance (see below). Dogs may have proven useful for the management of sheep (Baldwin 1978:104-105) and cats, some of which were presumably domesticated, probably helped control the threat of rodents to agricultural products.

Living domestic animals probably constituted wealth in their own right - insofar as their ownership symbolised the power to pay rent, conduct exchange or support labour through feasting (see Chapter 6 below). More importantly, however, they provided food and secondary products as both living animals and carcasses.

A wide variety of animal products were probably of considerable economic importance. Urine might have been used for wool processing (Buckland & Perry 1989:42), horse hair for fishing lines (see Section 5.6 below) and dung for fuel (Ben 1805[1529]:434), manure (Withrington & Grant 1979[1791-1799]:244) and possibly pottery temper (Gaimster 1986; Ross 1994). Animal carcasses must also have provided hides, bone and horn for the manufacture of clothing and tools .

The primary role of livestock, however, was probably transportation or traction and the supply of meat products, milk products and wool. Historical evidence suggests that the consumption of meat was commonplace in medieval Scandinavia (including Orkney), at least among aristocratic classes (e.g. Pálsson & Edwards 1981:56; Sephton 1899:143, 145, 161, 169, 197, 213). Zooarchaeological data imply a similar, if somewhat less exclusive, culinary pattern in the Viking Age and Late Norse earldoms. The potential role of intensive dairying has been emphasised in the past (see below), but the ubiquitous presence of pigs in faunal assemblages from Orkney, Caithness and Shetland (Figure 5.21) is ample evidence of a society well associated with the consumption of meat.

While the carcasses of all domestic taxa could have provided food, horses are unlikely to have been eaten after conversion to Christianity. Pope Gregory III forbade the eating of horse by Christians in the 8th century AD (Serjeantson 1989:7), a convention adopted in Scandinavia. An anecdote from the 13th century *Sverri's Saga* is enlightening in this regard. When local farmers refused to help the king's war party he

> command[ed] two horses to be brought forward that they might be slain for food, he said that if they were so sparing of their food, the story would be told in every land how Christian men, to preserve life, were compelled to eat horse-flesh in their country (Sephton 1899:32).

In the absence of relevant evidence it is probably unwise to speculate on whether dogs and cats were viewed as appropriate for human consumption (see Hufthammer 1994:236-237). Butchery marks do occur on cat bones from Earl's Bu (Mainland pers comm.). However, they could derive from either skinning or food preparation.

Despite the likely importance of meat, much historical evidence for pastoralism relates primarily to the use of products from living animals. This is not surprising, given that butter (which could derive from cow's or ewe's milk) and, in the case of Shetland, wool cloth entered the historical record due to their role as media of taxation and trade. The evidence, including records of rent, tax and tithe is discussed in more detail in Section 6.8.4 below. The earliest is an addition to the *Orkneyinga Saga* referring to butter payments (derived, in this instance, from cow's milk) in Caithness in 1222 A.D. (Crawford 1985b:28; Dasent 1894a:232). Records of secular payments in butter exist only in later, 15th and 16th century, rentals (Goudie 1904:171-177; McNeill 1901:325-327; Thomson 1987:119-120).

Wadmel (wool cloth) appears in 16th century documents relating to Shetland (McNeill 1901:325-327; Goudie 1904:173, 176; see Smith 1984:37). It may also be obliquely referred to - by mention of a unit of length used for cloth (*stykke*) - in a 15th century document (Lange & Unger 1849-1919:Volume xii 123-124; B. Smith pers comm.). There is a paucity of direct historical references to wool production in Orkney and Caithness (perhaps due to differences in the products of exchange, see Section 6.8.4 below). Nevertheless, there is ample evidence for weaving. *Njal's Saga* (written c.1280 in Iceland) provides a vivid literary example (Magnusson and Pálsson 1960). A man had a vision which foretold the defeat of Earl Sigurðr of Orkney at the Battle of Clontarf in 1014:

> On the morning of Good Friday, it happened in Caithness that a man called Dorrud went outside and saw twelve riders approach a woman's bower and disappear inside. He walked over to the bower and peered through the window; inside, he could see women with a loom set up before them. Men's heads were used in place of weights, and men's intestines for the weft and warp; a sword served as the beater, and a shuttle was an arrow (Magnusson & Pálsson 1960:349).

Artifactual evidence is also relevant. Implements associated with textiles, such as loom weights, spindle whorls and pin beaters are ubiquitous in Late Norse and Viking Age assemblages from Orkney, Caithness and Shetland (e.g. Batey 1989a:214; Batey et al. forthcoming a; Crawford 1985a:150-151; Curle 1982:81-82; see Morris & Rackham 1989:214). It is also possible, however, that linen was the product of some looms in the earldoms (Bond & Hunter 1987; Donaldson & Nye 1989:266; Pálsson & Edwards 1981:100).

Artifactual evidence *may* also indicate the exploitation of milk in the Viking Age. Bone items found at Jarlshof, Shetland, have been interpreted as lamb bits (Hamilton 1956:146). These have been used in early-modern contexts to prevent lambs from sucking and may provide evidence for the importance of ewe's milk in Shetland (see Bergsåker 1978:88-90). As relatively isolated finds, however, it would be unwise to stretch their implications to include intensive milk production.

Faunal evidence from the Viking Age and Late Norse Period can provide further evidence regarding the relative importance of secondary animal products in the pastoral economy. Legge (1981:86), for example, has suggested criteria for identifying dairy economies from faunal assemblages. The age profile of cattle bones should include predominantly old females and very young individuals (although in practice, useful sex data are rarely available). New calves are necessary to induce milk production and productive animals would be kept into maturity. Age profiles have also been used to interpret the economic role of sheep. Animals raised for wool or milk would presumably be kept longer than those intended to provide only meat. Furthermore, surplus lambs which might consume milk desired for human use would be slaughtered (e.g. Rackham et al. forthcoming d; Rowley-Conwy 1983:110).

In his preliminary analysis of faunal material from Sandwick, Shetland, Gerald Bigelow (1984:133-134; see also 1989:188; 1992:19) suggested that cattle bones were characterised by very young (most possible less than six months and some possibly less than 5-9 weeks) and fully adult individuals. He interpreted this evidence - in combination with an increase in the relative abundance of cattle over sheep from the 12th to 14th centuries and architectural evidence for the stabling of cattle in longhouse dwellings at Sandwick, Jarlshof and possibly Underhoull - as evidence for an intensification in dairying activity during the transition from the Viking Age to the Late Norse Period (Bigelow 1984:133-134, 228-229, 283; 1987:32-34; 1989:188; 1992:19).

While Bigelow's elegant model has been widely influential (e.g. Amorosi 1989a:219; McGovern et al 1988:261; Rackham et al. forthcoming d), it is based on relatively modest data. The preliminary faunal analysis on which his age estimates were based included 693 identified cattle bones (Bigelow 1984:Tables 11-13). Although he mentions "*numerous* mandibles and maxillae with unworn, or only lightly worn deciduous dentition and unerupted first molars" and "*many* unfused atlas vertebrae" the aging evidence cannot have been extensive given the small total number of cattle bones (Bigelow 1984:134 emphasis mine). It should also be noted that Legge's (1981:86) classic criteria for a dairy economy - which implies the need to kill calves which might compete with humans for milk - has recently been challenged. McCormick (1992), using historical data from Ireland, and Peske (1994), using pictorial evidence from Egypt and Mesopotamia, both suggest that calves had to be kept alive in order to stimulate the milk release reflex in pre-improved breeds. While these arguments may not be universally applicable, it is necessary to treat traditional interpretations of cattle age distributions with caution.

No additional data are available from Shetland, but faunal assemblages from Orkney and Caithness are not entirely consistent with either a specialised dairy economy or a change in its intensity over time. First, there is little evidence for a chronological trend in the relative abundance of cattle *vis-à-vis* other domestic mammals. Second, even accepting Legge's model, the age profiles of cattle from many Viking Age and Late Norse contexts are as consistent with a multipurpose pastoral strategy as with a specialised dairy economy.

Figure 5.21 illustrates the relative abundance of the four major domestic mammals, at the species level, arranged in approximate chronological order. With the exception of the Freswick Links sites (in two of which - NCA, MCA - the fragment count of cattle is probably exaggerated by articulated partial skeletons [Gidney forthcoming]) there is little clear evidence for an increase in the relative abundance of cattle. The absence of a marked temporal trend is more clear in Figure 5.22. In this case, large mammals (including the categories *cattle*, *horse*, *large hoofed mammal* and *large mammal*) and medium mammals (including *sheep/goat*, *sheep*, *goat*, *pig*, *small hoofed mammal* and *medium mammal*) are combined and contrasted. Thus, biases introduced by inter-observer differences in the degree to which, for example, sheep bones were identified to *Ovis/Capra*, *small ungulate* or *medium mammal* are minimised. It would seem that the remains of cattle *vis-à-vis* sheep and pigs (which make up the majority of the medium mammal category) were, with a few exceptions, approximately equally represented on both Viking Age and Late Norse sites in the earldoms.

Two notable anomalies in Figures 5.21-5.22 deserve special comment. Cattle (or *large mammals*) were particularly abundant in all areas of Freswick Links and sheep (or *medium mammals*) were particularly common at the Beachview Studio site. As mentioned above, the former pattern is at least partially due to the presence of articulated cattle bones in NCA and MCA. It may also be relevant that Area 9 produced only a tiny assemblage (212 specimens) and Area 3 was a heavily disturbed deposit of mixed Pictish and Norse origin. It is tempting to accept the consistent abundance of cattle across Freswick Links as evidence of human behaviour. The data cannot, however, adequately sustain this position.

The high proportion of sheep at Beachview is evident in both sieved and unsieved assemblages. It would appear to represent a 'real' behavioural phenomenon, presumably interpretable in spatial rather than chronological terms. It is not immediately clear, however, why this single site differs so markedly from all others (see below).

The aging data from many sites in the earldoms include substantial numbers of cattle and sheep of immature age *as well as* neonatal and old individuals. As Rackham et al. (forthcoming d) suggest, this pattern is more consistent with multipurpose than dairy herds. Regrettably, aging data have not been consistently published to a standard which would facilitate meaningful tabular representation. The available evidence is therefore summarised in narative form in Appendix 5.7.

Overall, the Viking Age and Late Norse faunal assemblages from Orkney, Caithness and Shetland do not reveal clear-cut evidence for an intensive economic focus on milk or wool production. This lack of confidence is partially due to methodological issues such as small sample size or (regarding the Brough of Birsay) uncertainties surrounding preservation, recovery and analytical strategy (see Appendix 5.7). It is suggestive, however, that substantial collections such as Beachview imply a mixed economy (Rackham et al. forthcoming d). Moreover, the fact that animals of intermediate age (not skeletally mature but greater than c.1 year old) are represented in the remaining assemblages is consistent with this interpretation (Appendix 5.7). The cattle data from several Viking Age (Buckquoy, Pool) and Late Norse (Sandwick, Freswick Links NCA) sites do exhibit the over-representation of young individuals traditionally interpreted as evidence for dairying (Bigelow 1984; Bond 1994; forthcoming; Gidney forthcoming; Noddle 1976-1977). As Rackham et al. (forthcoming d) argue, however, this evidence is equally consistent with a multi-product strategy in contexts where animals of intermediate age are also well represented. This discussion is not intended to imply that milk and wool were unimportant. The artifactual and historical evidence demonstrates the likely importance of both wool cloth and butter. However, the pastoral economy should probably be perceived as extensive (intended to produce a diversity of resources) rather than specialised.

It is tempting to correlate differences in the mammal assemblages - in terms of species composition and age profiles - with the possible function and status of the sites from which they came. This approach has been applied with great success in Norse Greenland - using architectural evidence and the area of usable land as criteria for ranking the status of settlements (McGovern 1985; 1992; 1994). In particular, apparently anomalous assemblages such as Beachview (with a high sheep count) and Pool (dominated by neonatal cattle bones, Bond, forthcoming) demand an explanation in terms of a wider pastoral system. Regrettably, however, this approach is not easily employed in the Norse colonies of Scotland. The archaeological record from the earldoms does not resemble Greenland, where single farms undisturbed by later activity occupy distinct regions of usable land. In Orkney, Caithness and Shetland few middens can be associated with particular structures or a definable catchment area. The density of (often undated) settlement remains and the degree of settlement destruction by agricultural activity is simply too great. Moreover, while some sites can be confidently associated with high status occupation (by saga reference or precious metals, for example) it is difficult to define a 'low status' site without arguing from negative evidence.

The Beachview sites, with their anomalously high proportion of sheep, provide a useful example of the complexities involved. If the social significance of different livestock was similar in medieval Orkney and Greenland (see McGovern 1992:219), it may be appropriate to interpret Beachview as a relatively low status settlement. However, this suggestion is not entirely consistent with the artifactual remains. Hacksilver and ivory were recovered at the Beachview studio site (Batey et al. forthcoming b). The rich agricultural hinterland (Macaulay Institute for Soil Research 1983b; Morris & Rackham 1989:213-214) could support a high status interpretation, but it must have been divided among the several known (and presumably more unknown) Norse settlements in the area (see Morris 1993). This division was probably uneven given the elite complex across the bay on the Brough of Birsay (Curle 1982; Hunter & Morris 1981; 1982; Hunter 1986).

These difficulties may not always be insurmountable. For example, one can be fairly confident (based on saga, artifactual and structural evidence) that Earl's Bu was a domestic settlement associated with the earl's of Orkney in the Late Norse Period (Batey pers comm.; 1993a; Batey & Morris 1992; Fisher 1993; Morris et al. 1994:145-147; Pálsson & Edwards 1981:99, 125, 195; see Table 6.7). However, issues of site status and function are better discussed using a variety of evidence rather than exclusively in terms of the mammal assemblages. They are therefore considered in more detail in Chapters 7 and 9 below.

5.6 Fishing

Although fishing is mentioned in *Orkneyinga Saga* (Pálsson & Edwards 1981:124, 132, 158-160), its importance in the Viking Age and Late Norse earldoms is best illustrated by zooarchaeological evidence. Fish bones are abundant at all sites for which faunal data exist. Regrettably, analytical differences among classes of bone prevent direct comparison of the relative abundance (by fragment count) of mammal, bird and fish in all but 11 of the available assemblages (see Table 5.1 and Appendix 5.1). Moreover, even within this group substantial differences in recovery strategy lead to results which are not strictly comparable. This caveat aside, Figure 5.23 illustrates the substantial proportion (from 26.9 to 98.5%) of fish bone recovered in virtually all assemblages for which inter-class comparisons are feasible. The Brough of Birsay, characterised by extremely poor fish bone preservation (Colley 1989:258), is the single exception (1.0 to 1.1% fish). Much of the variation within the remaining assemblages can be explained by recovery procedures. Sites where little or no sieving was conducted tend to have lower proportions of fish than those where all sediment was sieved. Furthermore, the two assemblages recovered using the smallest mesh size (Beachview Burnside and Studio Site) have the highest proportion of fish bone after the fish midden at Robert's Haven. The remaining variability in this data set - such as the relatively low proportion of fish bone at Earl's Bu (given comprehensive sieving) - can probably be attributed to differences in site function and preservation. These issues are taken up further in Chapter 7.

The degree to which fragment count data can be affected by differences in recovery strategy is evident from Figure 5.23. For example, the proportion of fish bone from the Beachview Studio Site varied from 42.0% (hand collected) to 97.3% (sieved). The difference is particularly notable for this assemblage partly because the mesh aperture used for recovery was less than 1mm. Large numbers of small unidentifiable fragments were therefore included in the fish count. To address this problem it is useful to consider the relative importance of fish using both fragment counts and bone weight. The latter measure is less affected by the presence or absence of tiny unidentified fish bone fragments. Moreover, bone weight can serve as a proxy measure of potential meat yield (see Section 5.2.4). Fragment counts essentially estimate the abundance of fish in an assemblage without revealing their potential dietary importance. An assemblage of small saith, amounting to little usable food, could yield the same fragment count as a collection of large cod constituting a significant economic resource.

Some useful weight data are available regarding four assemblages: Robert's Haven, Freswick Links (only the 47 resorted samples from NCA), Earls Bu and Beachview Burnside Area 2 (sieved assemblage) (see Table 5.13). For Beachview, however, no information is available regarding bird bone (Rackham pers comm.). The results confirm the potential dietary importance of fish in the Late Norse earldoms, but also indicate how ratios based on fragment counts can sometimes be misleading large if interpreted in nutritional terms. Fish constitute 97.3% of the total bone weight at Robert's Haven, 84.2% at Freswick Links NCA, 13.0% at Earl's Bu and 25.8% (excluding bird) at Beachview Burnside. The semi-specialised deposit at Robert's Haven remains dominated by fish (as are the Freswick Links samples for which fragment count data were not available). However, the representation of this class at the probable domestic settlements of Beachview and Earl's Bu is reduced considerably compared to fragment counts. Excluding issues of taphonomy and allometry, a Late Norse household such as Earl's Bu might have processed c. 13% of its available meat as fish. Given taphonomic biases against the survival of fish bone (see Section 5.2.2 above) and differences in the ratio of bone weight to body weight between gadoid fish, birds and mammals (see Table 5.3), this figure probably underestimates the real contribution of marine resources to the inhabitants' diet. Definitive statements of this sort are not possible for the Beachview assemblage given the absence of data regarding bird bone. Nevertheless, with a ratio of fish to mammal of 25.8% it is likely that the former were more important at Burnside Area 2 than at Earl's Bu. Bird bone constitutes a small proportion (0.1%) of the Beachview assemblage by fragment count and would probably have a similarly tiny impact on weight data.

Although approximately 75 fish taxa are represented in Table 5.6, inhabitants of both the Viking Age and Late Norse earldoms seem to have focused on exploitation of cod family fishes. Figure 5.24 illustrates the proportion of gadoid and non-gadoid specimens in 16 assemblages for which analytical strategies facilitate direct comparison. Although Gadidae and other taxa were frequently analysed differently, they are usually comparable if gadoid fishes are grouped at the level of family (see Table 5.1 and

Appendix 5.1). In no case do all taxa belonging to families other than Gadidae reach even 10% of the total fragment count. Although this pattern could conceivably represent recovery bias in unsieved assemblages - cod family fishes are often large - it holds even at the Beachview sites where 0.895mm mesh was used for recovery. Moreover, it is possible to use results from Earl's Bu as a test case. If only elements which were sorted from both the >4mm and <4mm sample fraction are considered (dentaries, premaxillae and vertebrae), non-Gadidae taxa remain a tiny proportion (less than 5%) of the assemblage (see Table 8.23).

This discussion is not intended to suggest that fish from families other than Gadidae were not purposefully sought. Some almost certainly were, and may well have been valued for their comparative rarity. Salmonids - salmon and trout - occur in both Viking Age and Late Norse assemblages (Table 5.6). Their bones are difficult to distinguish and are often identified only to the family or genus level. They could have been caught by hook, spear or net in the streams and lochs of Orkney and Shetland and particularly in the rivers of Caithness (Maitland & Campbell 1992:98-126; von Brandt 1984:46; 219). Some could also have been caught at sea or from the shore (Whitehead et al. 1989:381-382). Although salmon and trout may be more abundant in streams or rivers during the summer spawning migration, the taxa of northwestern European waters are essentially a year-round resource (Irving 1994).

The potential value of salmonids, at least in the post-medieval period, is illuminated by court proceedings of c.1500. A farmer in Mainland, Orkney, was in dispute with a neighbour over construction of a mill which interfered with the passage of fish, presumably trout, up stream to his property (Clouston 1914:74-76). It is also suggestive that a commercial fishery for salmon on the River Naver, Sutherland, was recorded in the 16th century (Murray 1993). Rights to fisheries of Wick (presumably for salmon) are also recorded in a 16th century document which may ultimately relate to division of the inheritance of Joanna, daughter of Earl Magnús II, in 1239 (Crawford 1982:65).

These historical records are interesting for their rarity. References to fishing are not common among the post-medieval legal records of Orkney and Caithness. Shetland is somewhat better served due to the development of direct trade in fish with the bureaucratic Hanseatic League after 1415 (Friedland 1973; 1983). This could be taken to imply that fishing was unimportant, or even that the most important taxa were salmonids, in the centuries immediately following the Late Norse Period. By analogy, these interpretations might then be extrapolated to at least the last few centuries of present interest.

The zooarchaeological evidence, however, illustrates that neither of these suggestions can be sustained. The substantial importance of fishing has been discussed above and no more than eight salmonid bones have been recovered from any one site in the earldoms. Salmon remains have a relatively low density (particularly during summer spawning), and can thus be subject to differential preservation (Butler & Chatters 1994). However, this alone cannot account for the fact that only c.25 bones have been recovered from 23 assemblages of Viking Age and Late Norse date (Table 5.6). While salmon fishing stations of Viking Age or medieval date may one day be found on the rivers of Caithness (including Sutherland), the discrepancy between the historical and archaeological record may have a relatively prosaic explanation. Access to rivers and streams could be controlled and owned under 15th-16th century Orcadian law (Clouston 1914:74-76). Thus, issues concerning their use entered legal records. Disputes regarding agricultural land and payments in kind, which fill many pages of the earliest surviving court books (e.g. Barclay 1967), are similarly concerned with 'property'. The sea, beyond "the lawest of the se and sand" (Clouston 1914:82), seems not to have been an owned resource (although rights to fishing locations, identified through triangulation from landmarks called *meiths* in 19th century Shetland, might have been unofficially claimed [see Goodlad 1971:101]).

Eels, which are relatively common in assemblages which were recovered using fine mesh (see Table 5.6 and, for the <4mm sample fraction from Earl's Bu, Table 8.23), were probably also systematically exploited. They can be easily caught using wicker traps in streams (von Brandt 1984:177-179). Eels were a valued food in Scotland during the middle ages, figuring in the royal Exchequer Rolls (Ewan 1990:67).

Some flatfish may also have been purposefully sought, possibly using the techniques of spearing and seine netting described by Colley (1983a:106, 115; predominately after Low 1813). It is also possible, however, that the relatively few individuals represented were incidental catches during fishing from shore and boat for gadoid taxa such as saith and cod (see below) Although halibut was an important economic resource by the 14th century in Norway (Vollan 1959:343-344), it seems to have been an incidental catch in the Scottish colonies. The large bones of this species are extremely rare.

Herring require some comment, as they were the focus of enormous Dutch and Scottish fisheries off Caithness and the Northern Isles from the 16th to 20th centuries (Gray 1978; Smith 1984:25). Moreover, this species was of considerable importance in Scandinavia and Scotland during the Middle Ages (Ditchburn 1990:77; Stevenson 1988:186). Perhaps contrary to expectation, it constitutes an incidental component of the Viking Age and Late Norse assemblages under consideration. Herring is relatively rare even at sites sieved to 1mm or less (see Table 5.6 and, for the <4mm sample fraction from Earl's Bu, Table 8.23). It is tempting to view this pattern as further evidence for a specialised fishery focusing on cod family taxa. The two groups would require different fishing technology. Gadidae taxa were probably caught with hook and line (see below), while herring are typically netted (Sutherland 1985). Moreover, many herring bones could have arrived on site as the gut contents of cod family fishes (Muus & Dahlstrøm 1974:101, 111; Whitehead et al. 1986a:686).

It is difficult to assess the potential significance of cartilaginous fish on the basis of archaeological material. On the whole, only mineralised vertebral centra, dermal denticals and teeth are likely to be identified (Wheeler & Jones 1989:79-86). Four taxa have been identified to species (Table 5.6). The smallspotted catshark and spurdog are both bottom living fish found from relatively shallow waters to considerable depths (Whitehead et al. 1989:99, 146). The spurdog occurs in large shoals (Whitehead et al. 1989:146) and may thus have provided a focus of intentional fishing activity. Dogfish provided food and oil in early modern Orkney (Fenton 1978:531). It may be relevant to interpretation of the Earl's Bu assemblage that a specialised fishery for dogfish was conducted from Orphir, the parish in which the site lies, in the 18th century (Withrington & Grant 1978[1791-1799]). The tope (a relatively small shark) and thornback ray can be found in both coastal and deep water (Whitehead et al. 1989:118-185). The latter species is bottom living, the former free-swimming.

Most other non-gadoid species represented in Table 5.6 are probably best interpreted as incidental catches while fishing for the dominant cod family taxa. Littoral and shallow water fish, such as the bass, wrasses, the butterfish, cottids, the thicklip grey mullet, sea breams, and some flatfish (e.g. the topknot, dab, plaice and flounder) could be caught while fishing for small saith (either close to or from the shore). Deeper water taxa such as gurnards, the angler, the halibut and the megrim are perhaps more likely to have been caught while fishing offshore for large cod, saith, ling or haddock (see below). These distinctions are not absolute as some species exhibit considerable variability in ecological range (Whitehead et al. 1986a; 1986b; 1989). As mentioned above, some taxa (such as herring, sand eels, and gurnards) could also represent the gut contents of cod family fishes (Muus & Dahlstrøm 1974:101, 105, 111, 115; Whitehead et al. 1986a:686). The two possible tuna specimens from Pool are curious, but tunny do migrate as far north as Norway in search of food after spawning (Muus & Dahlstrøm 1974:142).

As discussed above, the preponderance of cod family fishes in the study assemblages strongly suggests the existence of specialised fishing practices. Even within this family, a narrow range of species have dominated the samples and, by implication, Viking Age and Late Norse fishing activity. Figure 5.25 illustrates the relative proportion of the five abundant cod family fishes: cod, saith or pollack (*Pollachius* sp., the vast majority of which are saith), ling, haddock and torsk. Small numbers of other taxa (including the related hake) make up only 0.6% of all gadoid specimens identified to genus and species.

Cod and saith together dominate all of the Viking Age and Late Norse assemblages, with the relative proportion of each at least partially dependent on recovery. Large numbers of saith can be lost through coarse mesh as they sometimes have a smaller size distribution than the other main gadoid taxa (see below). Ling is typically the third most abundant taxon, with haddock and torsk (if present) following in that order. Anomalies include Sandwick (where torsk is well represented in both phases), the Beachview sites (where saith were particularly abundant) and Earl's Bu (which yielded more specimens of haddock than of saith or ling). The proximity of the continental slope off northern Shetland (Hydrographic Office 1993a) probably accounts for the first of these examples. Torsk are a deep water fish (Whitehead et al. 1986a:697). The second and third anamolies are discussed below. There is no apparent chronological pattern in the data, with the possible exception of an increase in the relative proportion of saith (see below).

The potential effect of recovery on the relative abundance of saith is illustrated by the high proportion of this taxon in the sieved Beachview assemblages (where all sediment was passed through particularly fine mesh). It is also likely, however, that these two sites had a high proportion of saith to begin with. Tables 8.4 and 8.23 illustrate the relative proportion of the main cod family taxa at Robert's Haven and Earl's Bu based only on those elements sorted from both the >4mm and <4mm sample fractions. The proportion of saith increases very slightly over the >4mm results, but remains substantially lower than at Beachview. This is particularly evident at Earl's Bu, where the proportion of saith remains tiny.

This difference illuminates variability within the Gadidae data set which is not exclusively a factor of recovery. The Beachview sites are anomalously rich in saith while Earl's Bu is anomalously poor in the same species. Moreover, as evident from Figure 5.25, Earl's Bu has a striking proportion of haddock not paralleled elsewhere in the earldoms (with the exception of a tiny assemblage from Freswick Links Area 9). The possibility that this pattern is taphonomic in origin is considered in Chapter 7 below. Some haddock elements are prone to hyperostosis and are thus extremely robust (von den Driesch 1994:37-38). Assessments of taphonomic attrition, however, suggest that the anomalous taxonomic pattern at Earl's Bu relates to behavioural rather than preservation factors (see Chapter 7).

Given the extremely high proportion of saith in the sieved assemblages from Beachview it is tempting to assume that sediment destined for sieving was first hand collected (and thus that the sieved and unsieved assemblages are not distinct data sets). This could account for the high proportion of cod in the hand collected assemblages if excavators made little attempt to recover smaller saith knowing that sediment would be sieved. However, the relevant site reports imply that sieved and unsieved areas of both Burnside Area 2 (Rackham et al. forthcoming a) and the Studio Site (Rackham et al. forthcoming b; forthcoming c) were kept distinct. Furthermore, the hand collected mammal assemblages do not show a superabundance of bone from large taxa (in fact they show the reverse, see Figures 5.21-5.22).

Although apparently real, it is difficult to suggest a definitive explanation for the high proportion of saith in the sieved Beachview assemblages. It is interesting to note, however, that the same deposits yielded a high proportion of sheep. The possibility that this could imply settlement of relatively low status has been raised above. Although this interpretation is contradicted by some artifactual evidence (see Section 5.5 above), Beachview does present an interesting contrast to many other sites in the earldoms. A behavioural explanation of some kind seems inevitable - be it in terms of social status or site function.

Despite some variability among assemblages, the fact remains that three or four cod family taxa were the primary target of fishing activity in the Viking Age and Late Norse earldoms. It is possible to draw preliminary conclusions regarding the character of this activity through consideration of fish ecology, historical records and artifactual finds of fishing equipment. However, the habitats of cod family taxa (particularly saith) are dependent on fish age and size. It is thus useful to reconstruct the size distribution of fish represented in the Norse assemblages before attempting to discuss the character of past fishing. I begin with previously unpublished results from Robert's Haven and Earl's Bu, then consider other assemblages for which useful data are available.

Figures 5.26-5.32 illustrate estimated size distributions for cod, saith, ling and Haddock from Robert's Haven and Earl's Bu based on premaxillae and dentaries from both >4mm and <4mm sample fractions. Any impact of sieve size is thus minimised. These estimates are based on linear measurements of specimens in sufficiently good condition. The methods employed are explained in Section 8.3.2 below.

Available size data regarding cod, saith, ling and haddock from other Viking Age and (predominately) Late Norse assemblages are presented in Figures 5.33-5.50. Sites and species for which few data were available have been omitted from consideration. Moreover, distinctions based on recovery and phase made in Table 5.1 and Appendix 5.1 do not apply in all cases, as measurements have often been presented as pooled data sets. At Beachview, for example, all sites and both sieved and unsieved material are combined (Rackham et al. forthcoming d). For all cases except Pool (for which bone by bone measurements are available) data have been derived from published (or privately distributed) histograms prior to applying regression equations to predict total fish length from element dimensions. The equations used, based on Jones (1991a:164), are outlined in Section 8.3.2 below. Details regarding each site - including the elements measured, measurements and references - are presented in Appendicies 5.5 and 5.6.

At Robert's Haven, cod range from 102mm to 1235mm in estimated total length with means of 653mm (premaxillae, n=119) and 646 (dentaries, n=119). Both premaxillae and dentaries exhibit a bimodal distribution with peaks between c.400-600mm and c.800-1000mm (Figure 5.26). The smaller Earl's Bu assemblage yields similar results, with total length estimates ranging from 234mm to 1170mm and means of 613mm (premaxillae, n=73) and 598mm (dentaries, n=34). The larger premaxillae data set has a bimodal distribution comparable with Robert's Haven. This pattern is not as clear in the smaller sample of measurable dentaries, but the distribution is (positively) skewed (Figure 5.29).

The estimated size distributions for cod from other sites in the earldoms are broadly comparable to the results from Robert's Haven and Earl's Bu. The degree of bimodality varies from site to site - probably partially dependent on sample size and recovery strategy - but is a relatively consistent feature. All sites exhibit the mode of c.800-1000mm while assemblages which lack evidence for another between c.400mm and c.600mm are at least negatively skewed.

As discussed in Section 2.5, cod of all sizes can be found from the shoreline to depths of 600m, although large individuals tend to inhabit deeper waters than young fish (Muus & Dahlstrøm 1974:98; Wheeler 1978a:150; Whitehead et al. 1986a:686). Some oceanic populations are strongly migratory (Garrod 1977:217), but the coastal and North Sea stocks available off northern Scotland are available throughout the year (Lee & Ramster 1981:3.06; Muus & Dahlstrøm 1974:98-102).

Several explanations could account for the bimodal distribution evident in the cod size estimates. As this species is gregarious (Whitehead et al. 1986a:686), and fish shoals consist of animals of similar age (Muus & Dahlstrøm 1974:11), it is possible that the modes represent different habitats (and therefore fishing areas) preferred by fish of different size. It is possible to speculate, for example, that the smaller fish might have been caught closer to the shore. Conversely, the two size groups could represent fishing activity in a single area in different seasons. This possibility, however, assumes local migrations of coastal cod which are currently poorly understood (see Section 2.5). A third possible explanation is the use of two sets of fishing technology. Hook size, for example, can effect the size of fish caught (Owen 1994). It is possible that smaller fish were purposefully sought, perhaps for immediate consumption or drying without salt (see Section 8.2 below).

In recent times, large cod have been caught predominantly by trawl and by long line - a line with multiple hooks anchored along the ocean floor (Goodlad 1971:107-109, 138; Muus & Dahlstrøm 1974:101). Trawling is a recent innovation in Scotland, being introduced amidst angry local reaction in the 1880's (Gray 1978:166-180; Sutherland 1985:47, 49-50). Although it has been suggested that long lines were employed in the Norse period (Wheeler 1976-77:214), the earliest record of their use in northern Scotland derives from the 16th century (Irvine & Morrison 1987:52; see also Coull 1972:79). Moreover, putative sinkers recovered from Norse sites in Shetland and Orkney (e.g. Curle 1982:82; Bigelow 1984:262-266; Hamilton 1956:Plate 34) are too small and streamlined to be long line weights, which must anchor many fathoms of gear to the sea floor. Long line anchors of recent centuries have been discoidal or irregular perforated stones often more than 7kg in weight (Goodlad 1971:107-109; Leask 1993). Examples survive in the Shetland Museum (reference numbers 3687 & 4029).

The most likely candidate for Late Norse fishing technology is the hand line, which (based on 19th and early 20th century analogy) might entail a wooden reel, a small streamlined weight, and c.60 fathoms of line ending in several hooks attached by horse hair "toams" (Fenton 1978:585-594; Goodlad 1971:59, 108, 138; Leask 1993; Shetland Museum records 725, 769, 1605). It is interesting to note in this context that legislation against the plucking of hair from horse tails was included in the 17th century Orcadian Country Acts passed to temper Scottish law to Norse custom (Barclay 1967:29). In recent centuries, hand lines were often used from small boats of 4-7m keel called yoles, fourareens and sixareens in Shetland (Fenton 1978:565-567, 587; see Figure 5.51). It is probable, as others have suggested (e.g. Baldwin 1982; Bigelow 1984:198), that the 12th or 13th century account of Earl Rǫgnvaldr's fishing trip off Sumburgh, Shetland, describes hand line fishing:

> Then they rowed out beyond Sumburgh Head and beyond Horse Island. There were strong currents where they were fishing and large eddies; they had to keep the boat in the eddy but fish out of the tide-race. The hooded

man [Rǫgnvaldr] sat in the bows and rowed against the current, but the crofter had to do the fishing (Bibire, 1984:84, 96).

It also seems reasonable to assume that Viking Age boats represented in graves at Scar, Sanday, (Owen & Dalland 1994) Westness, Rousay, (Kaland 1993:314-316) and perhaps Huna, Caithness, (Batey 1993b:152) fulfilled a similar function several centuries earlier (see Figure 5.52). It is also possible, however, that some of the smaller cod were caught from land - perhaps while fishing primarily for saith (see below). The tiniest fish (<20cm, for example) could also represent the gut contents of larger cod, saith, ling and other taxa (e.g. Whitehead et al. 1986a:686, 691, 703).

Saith from Robert's Haven range from 99mm to 1282mm in estimated total length, with means of 567mm (premaxillae, n=102) and 479mm (dentaries, n=111). As in cod, however, the distribution exhibits some evidence of bimodality. In size estimates from both premaxillae and dentaries the lower mode centres around 300mm. The upper mode, however, varies between the two measured elements. The dentaries exhibit a distinct peak between 800 and 900mm. Conversely, the premaxillae suggest a very diffuse mode between 1000 and 1300mm. This pattern is probably not indicative of a problem with the regression equations as it is also evident if size distributions are estimated qualitatively by comparison to reference specimens of known size (see Figure 5.53). Moreover, it is unlikely to be random variability as a Mann-Whitney test suggests that the two distributions are significantly different at the 99% confidence level.

It is difficult to suggest an explanation for this difference. It seems possible, however, that the upper and lower jaws of large saith were at least occasionally treated differently. It is conceivable that this difference may be associated with the removal of fishing hooks or tongues, activities which may also explain cut marks evident on jaw bones (see Section 8.4.5 below).

As few saith bones were recovered from Earl's Bu little can be said regarding the size distribution of this taxon. The relevant data, illustrated in Figure 5.30, simply indicate that individuals between c.400mm and c.650mm were caught. More useful comparative assemblages exist from other (predominately Late Norse) sites in the earldoms. The sample sizes are small in many cases, but data from the more substantial collections broadly resemble those from Robert's Haven. One mode, between c100mm and c.400mm, is clear with a second of smaller scale occurring at some point greater than 800mm. Slight inter-site differences in the position of the modes could relate to the seasonal distribution of fishing intensity (see below) or to inter-observer error during the measurement of specimens.

One assemblage, from Quoygrew, deserves special note. It follows a pattern broadly similar to Robert's Haven, but the cluster of smaller fish is divided into two groups creating a trimodal distribution. This pattern, which could result from either methodological bias or seasonal fishing patterns, is discussed further below.

In general, bimodality suggested by the saith size estimates may be easy to explain - and is probably of relevance to the analogous pattern among the cod data. Saith are found in shallow water for their first 3-4 years, during which they range from 15 to 55cm in total length according to modern data (Muus & Dahlstrøm 1974:110; Wheeler 1969:274). They are shoaling fish and according to Low's 18th century *Fauna Orcadensis* they were the target of two somewhat seasonal fisheries. First:

> The fry of the coal-fish appear first with us in May, but small quantities, and themselves very small. About August they begin to be taken with small rods in great numbers, but still this is nothing to the shoals that set in towards winter, when the sea begins to grow stormy; then the harbours of Stromness especially, and many other places, are quite filled with them, and thus they continue for the whole winter. About this time they measure from six to ten inches [c.152-254mm], and are very much esteemed; all ranks and ages eat them under the name of Sillucks. About March, the shoal, or what is left of them, begin to retire to the deep...(Low 1813:193).

In recent centuries these young saith were commonly caught by net or by simple rod and line both from the shore and from boats in shallow water (Baldwin 1982; Fenton 1978:529-529, 533).

The smallest saith represented at Robert's Haven and other sites may have been harvested in analogous ways - tiny fish represented at Quoygrew, Tuquoy and Beachview are particularly suggestive. However, the estimated size distributions also suggest the importance of slightly larger fish. Low goes on to say that:

> ...in May, when another fishing of them begins, under the name of kuths, they are fifteen [inches, c.381mm]; still they are tolerable for eating, either fresh, as our Orkney folks eat them, roasted with the liver, or dry (Low 1813:194).

If the growth rates of young saith were at all consistent between the Viking Age and the 18th century, it is likely that this second fishery was of considerable importance to the inhabitants of most of the earldom sites. Low does not describe how it was conducted, but Fenton (1978:528, 533) synthesises a variety of early modern sources which suggest that young saith could be caught in relatively shallow water from both the shore and boats. It is not unreasonable to suggest that the hook (or gorge, see

Steane & Foreman 1988:143) sizes used to catch these saith were also responsible for the smaller of the two modes evident in the cod data.

With one exception (see below) the distribution between tiny "Sillucks" (of c.150-250mm) and "kuths" (of c.380mm) is relatively continuous. This suggests that fishing took place sequentially through the year rather than in a single short season. If the latter occurred, the distribution of small saith should include several distinct modes representing year classes (Mellars & Wilkinson 1980). Spawning is a distinct seasonal event in saith, followed by rapid growth (of c.15cm per year based on modern data) for the first three to four years of life (Wheeler 1969:274). A fishery for young saith conducted near spawning time, for example, might therefore produce a distribution with modes at c.15cm (one year old fish), c.30cm (two year old fish) and c.45cm (three year old fish). In older fish environmental factors affecting growth begin to blur year classes.

As mentioned above, a multimodal distribution among the smallest saith occurs only at Quoygrew. Here it is possible that at least these fish were primarily exploited during a single season. It is impossible to say definitively, however, that other taxa (or even large saith) were not caught at another time of the year. Moreover, the apparent mode representing fish less than 200mm in total length may actually be a methodological bias. It is created entirely by bones classed as tiny (those with a dentary measurement 2 of less than 1mm [see Figure 5.42]) rather than measured (Colley 1983a:247). If this classification was done subjectively, rather than quantitatively, some "tiny" bones may actually have had measurements slightly over 1mm. In this case, the distribution of total length estimates based on Colley's data would match the bimodal pattern exhibited by other assemblages from the earldoms.

The larger saith represented in all of the relevant assemblages could have been caught purposefully or incidentally while fishing for cod of sizes represented by the mode of c.800-1000mm estimated total length. As discussed above, it is highly probable that this fishery was conducted by hand line from small boats - possibly within sight of land.

Given the relatively small quantity of ling bones recovered from the study assemblages, in comparison to large cod and saith, this taxon may have been caught as one component of a fishery focusing on the latter two species. Ling represented in the Robert's Haven assemblage range from 259mm to 1732mm in estimated total length (TL), with means of 1095mm (premaxillae, n=33) and 1015mm (dentaries, n=12). The sample size of measurable bones is too small to justify the identification of multiple modes (Figure 5.28). At three measurable bones, the ling assemblage from Earl's Bu is too tiny to merit comment. However, more useful data sets from Freswick and Sandwick suggest a distribution comparable to Robert's Haven, with a mode between c.1000-1600mm, some negative skewing and a few smaller outliers (Figures 5.39 and 5.50).

Today, ling are generally solitary deep water fish, living in depths of 300-400m. However, immature individuals are found inshore as shallow as 15-20m and fully grown individuals can also be found in these depths (Wheeler 1969:284; 1978a:167; Whitehead et al. 1986a:703). It should also be noted that historical sources suggest that ling were caught in Shetland's bays in the 18th century (e.g. Brand 1883[1701]:193-194). It can thus be surmised that, while this taxon is unlikely to be caught by angling from shore, its presence need not imply a deep water fishery many miles from the coast (contra Colley 1983a:382-383; 1983b:169; 1989:258).

In recent times, ling have been caught predominantly by trawl and by long line - a line with multiple hooks anchored along the ocean floor (Goodlad 1971:107-109; Muus & Dahlstrøm 1974:114). As discussed above, however, hand lines were the likely technology used in Viking Age and Late Norse Scotland.

With the exception of Earl's Bu (and a tiny assemblage from Freswick Links Area 9), few haddock have been recovered from Viking Age and Late Norse sites in the earldoms. Only four measured elements of this taxon were recovered at Robert's Haven. The size data from Earl's Bu are also modest, but suggest fish ranging from c.400 to c.650mm in total length (Figure 5.32). Haddock were similar in size at Freswick, the only other site to produce an assemblage of measured elements for this species (Figure 5.40). Haddock are benthic fish, generally living in depths of 40m to 300m (Whitehead et al. 1986a:687; Wheeler 1969:278). Their comparative abundance at Earl's Bu is discussed further in Chapter 7 below.

The remaining Gadidae taxa are best interpreted as stomach contents of the four dominant species (see Whitehead et al. 1986a:686, 691, 703) or as incidental catches associated with the above-mentioned fisheries. Pollack generally do not shoal, but can be caught in small numbers in the same environments as cod and saith (Low 1813:196-197; Muus & Dahlstrøm 1974:110; Whitehead et al. 1986a:690). Whiting can also be caught in small numbers in depths from 5 to 200m (Low 1813:197; Whitehead et al. 1986a:688). The rocklings vary in habitat - from littoral species such as the five-bearded rocking to the offshore bigeye rockling (Whitehead et al. 1986a:696-701). Nevertheless, most are relatively shallow water fish which might be caught along with small cod and saith.

Torsk and hake are both relatively deep water taxa. Their paucity in the Viking Age and Late Norse assemblages could imply that fishing was conducted in relatively shallow water, or that these taxa were not favoured for cultural reasons. Torsk are benthic fish, living in depths of 100-1000m and very rarely found in less than 50m of water (Wheeler 1969:279; Whitehead et al. 1986a:697). Hake occupy both the bottom and midwater, but are generally found in 100-300m at the edge and slope of the continental shelf (Whitehead et al. 1986a:678).

Although probably incidental catches, it is evident that some of the rarer cod family taxa saw cultural use. At Robert's Haven, for example, several pollack specimens exhibited cut marks and pollack, haddock and hake were represented by burnt specimens. The latter bones are possibly from disposal of food waste in a household hearth as there is no evidence of in situ burning in the Area A fish midden (see Section 8.3.5 below).

In summation, it is likely that fishing activity in the Viking Age and Late Norse earldoms was dominated by three foci. Eels and salmonids were probably caught in freshwater, possibly using traps and nets or hooks respectively. Small saith and cod were likely fished from shore, or from boats very close to shore. Finally, large cod, saith, ling and haddock were probably caught by hand line from boats - possibly within a few kilometers of shore if 18th century accounts regarding the inshore distribution of ling can be believed. Virtually all other taxa, represented by very few bones, were probably incidental catches associated with these fisheries. It is also possible, however, that dogfish and shallow water flatfish were purposefully caught in modest numbers. Among all these possible fisheries, the exploitation of cod family fishes was probably by far the most important in terms of potential meat yield (and, as argued in later chapters, perhaps in terms of exchange value).

Much inter-site variability in fish taxa and size can be explained by analytical factors (such as recovery procedures and sample size). A few assemblages, however, exhibit anomalous patterns which may be indicative of distinctive human behaviour. Saith are extremely abundant at the Beachview sites (omitting hand collected material) and are poorly represented at Earl's Bu. Conversely, haddock are particularly abundant at the latter site. A definitive interpretation of these patterns is problematic, but the possibilities that they relate to status or taphonomic factors are discussed further in Chapter 7.

There is some evidence for a general increase in the importance of saith through time (see Figure 5.25). It is not possible to suggest a definitive explanation for this phenomenon. The simplest interpretation is that the pattern is caused by recovery bias.

Sieving with fine mesh has been more extensive at Late Norse sites (see Table 5.1). However, the increase in saith is also consistent with a model in which (often larger) cod and ling were differentially removed from the assemblages (conceivably for an export trade). As Bigelow (1984:199; 1985:121) has noted in reference to Sandwick, small saith were the staple of Shetlandic domestic subsistence during the 18th and 19th century, the climax of a commercial fishery for cod, ling and tusk (Fenton 1978:528-531, 571-584). It is also conceivable that the increasing proportion of saith in the Late Norse Period could relate to a change in the relative emphasis on shallow and deep water fishing.

5.7 Fowling

In recent centuries, birds (particularly wild seabirds) have been used as a source of eggs, meat, feathers and oil in the northern isles (Baldwin 1974; Serjeantson 1988). Typically, however, historical evidence is lacking for the Viking Age. Moreover, written evidence for their use in the Late Norse Period is limited to a saga reference regarding recreational hunting rather than economic exploitation (Pálsson & Edwards 1981:196). Zooarchaeological evidence is thus of exceptional importance for the interpretation of the potential role of wild and domestic birds.

The data of Table 5.7 facilitate several basic observations. First, birds, particularly domestic fowl, geese and seabirds, were a ubiquitous resource in both the Viking Age and Late Norse earldoms. However, their quantitative economic contribution must always have been modest. In terms of fragment counts, birds comprise 2.1% or less of the 11 assemblages for which the relative abundance of different classes is broadly comparable (Figure 5.23).

Second, domestic fowl make up a small percentage (from 0 to 18.7%) of each Aves assemblage (excluding Freswick Castle which is contaminated by modern material). Geese, some of which were probably domesticated (e.g. Allison 1989:248), are little more abundant (0-23.5%). Although both taxa would supply eggs (Sidell forthcoming) in addition to carcass products, they should probably be viewed as incidental farmstead animals rather than a focus of economic activity.

Wild seabirds were by far the most important taxa. As Serjeantson (1988:212) has noted, five seasonally available species - the gannet, guillemot, razorbill, puffin and manx shearwater - and two taxa available throughout the year - the cormorant and shag - were particularly common catches. Together, they constitute from 10.5% to 58.6% of virtually every assemblage considered in this study. Other seabirds, particularly gulls, are also consistently abundant. On the basis of ethnohistoric analogy (Fenton

1978:510-523), most were probably collected from breeding cliffs during spring and summer. They could be captured by hand, by clubbing, by snares and by nets (Searjeantson 1988:210). Although capture was often a seasonal event, birds were potentially a year round resource through drying and salting (e.g. Beatty 1992).

Seabirds were rare at only two sites: Freswick Links Area 9 and Earl's Bu. The first is irrelevant as it yielded only two bird bones. The second is more interesting. Mainland (pers comm.) suggests that the dominance of domestic taxa at Earl's Bu may relate to its direct association with the elite of Late Norse Orkney.

All the taxa represented in Table 5.7 could probably be acquired within a short boat trip of their find location (compare, for example, Figures 1.2 and 2.8). The gannet, however, is a possible exception. Presently, the colony nearest Orkney is on Sule Stack c.50km west of the archipelago (Searjeantson 1988:213). If this were the case in the Viking Age and Late Norse Period it could probably be assumed that great value was attached to the gannet. It seems likely, however, that more local breeding colonies existed in the past (Searjeantson forthcoming). Gannet bones occur in Neolithic contexts at Tofts Ness, Sanday, Orkney. As Searjeantson (forthcoming) suggests, it seems unlikely that the boat journey to Sule Stack would have been routinely practicable in the Neolithic.

Other taxa represented in Viking Age and Late Norse contexts may have been incidentally or regularly hunted in small numbers. The predators (particularly the eagles) may represent animals killed to protect domestic stock. Rewards were set for killing eagles in recent centuries (Fenton 1978:510). Smaller birds of prey such as the merlin and kestrel could be associated with the elite sport falconry (see Gilbert 1979:68), but more prosaic explanations are also possible. As a symbol associated with Odin, the raven (and perhaps related *Corvus* species) has potential ideological importance in the pre-Christian Viking Age (Mitchell 1993:444; Searjeantson forthcoming). However, the number of specimens identified is too small to detect any potential temporal trends in the abundance of this species. Crow taxa may simply have been killed due to their predatory or scavenging activities (Fenton 1978:510; Hamilton-Dyer 1991). Some specimens, such as bones of small passerines, may simply represent natural deaths (Hamilton-Dyer forthcoming).

As mentioned above, birds comprise 2.1% or less of the 11 assemblages for which the relative abundance of different classes is broadly comparable. Contrary to the suggestion of Allen (1995), this is unlikely to radically underestimate their potential dietary importance. Four of the assemblages were sieved in their entirety, two with 0.895mm mesh (see Table 5.1). While birds could have provided oil, this product was equally available from livers of the gadoid fish (Fenton 1978:527) which were heavily exploited on all sites under consideration (Table 5.6). Feathers might be archaeologically invisible, particularly if collected for exchange. However, it seems unlikely that carcasses would be left uneaten even if birds were collected primarily for a secondary product. The paucity of bones would thus imply that feathers were not a focus of economic activity either. Eggs, from both wild and domestic taxa, were certainly exploited (Sidell forthcoming). However, the seasonal availability of wild eggs and the small number of bones from domestic taxa suggest that this resource was also modest in scale.

5.8 Hunting

Medieval references to hunting in the earldoms are, like the record of fowling, allusions to elite recreation. *Orkneyinga Saga* includes anecdotes in which Earl Páll Hákonarson hunted otter on Rousay, Earl Haraldr Maddaðarson hunted hare (allegedly in Orkney, but see Section 2.4 below) and Earls Rǫgnvaldr Kali Kolsson and Haraldr Maddaðarson hunted deer (rauð dýri eða hreina) in Caithness (Guðmundsson 1965:275; Pálsson & Edwards 1981:138, 201, 209). The latter reference has sometimes been assumed to refer explicitly to reindeer, but this seems highly unlikely on ecological grounds (Clutton-Brock & MacGregor 1988). Red deer or roe deer were probably the target of hunting activity in Caithness (Corbet & Southern 1977:417, 433, 441-442).

Historical evidence for the hunting of seals and whales is restricted to references regarding other areas of Scandinavia and/or later periods. Whales were actively hunted as early as the 9th century in Arctic Norway (Fell 1984:20). Similar activities, usually conducted by driving pods of taxa such as the pilot whale into shallow water, were still carried out in recent centuries in Orkney (Fenton 1978:548-549) and Faroe (Bloch 1989). Larger whale taxa were probably scavenged if stranded, as salvage rights in medieval Norwegian law (Larson 1935:126-127) and a florid saga anecdote (Hight & Foote 1965:21-22) suggest. Seal hunting is perhaps better perceived as fishing, given the need to forbid eating seal meat during Christian fasts in medieval Icelandic law (Dennis et al. 1980:50). Nevertheless, it was conducted primarily on the beach in recent centuries in the Northern Isles (Fenton 1978:524).

The zooarchaeological evidence for hunting suggests that it constituted a very minor economic activity - at least in quantitative terms. Deer were never locally available in Shetland and were probably extirpated from Orkney in the Pictish period or early in the Viking Age (see Section 2.4 above). Deer were not consistently recovered from the sites in Table 5.5 and do not constitute more than 1.4% of any one assemblage. Even in Caithness, where red deer and roe deer are found to the present day, the proportion of Cervidae taxa never exceeds 0.5% of an identified mammal assemblage. Moreover, some of the deer 'bone' noted in Table 5.5 is probably antler imported for the manufacture of tools and personal accessories (see Section 6.8.2 below). Antler combs or comb fragments (recorded as artifacts rather than faunal material in the reports under consideration) are ubiquitous finds in both Viking Age and Late Norse contexts (see Tables 6.1 and 6.2).

Although not abundant, the fact that deer products had to be imported or sought in Caithness may be economically significant. The role of antler as a potential indicator of long range trade is discussed in Section 6.8.2 below. Moreover, access to leisure time, labour and land for hunting was conceivably an elite privilege. Stag hunting was predominately a joint effort and aristocratic preserve in medieval Scotland (Gilbert 1979; note the reference from *Orkneyinga Saga* above). It may thus be reasonable to perceive the acquisition of deer remains as a symbol, rather than source, of wealth. The two are often synonymous, insofar as access to prestige activities (the hunt) or objects (venison) could be used to secure labour. Nevertheless, in light of the small quantities involved, the concrete return from labour intensive hunting trips may have been modest.

Other hunted taxa were probably less socially meaningful. Otter bones occur at a few sites in very small numbers. Some may even be intrusive given the burrowing behaviour of this species (Corbet & Southern 1977:370; see also Nicholson n.d.b). Cat bones are relatively ubiquitous, but also represented by small numbers. Most specimens were probably from domestic animals (e.g. Bond forthcoming), but some could represent the wild cat (*Felis silvestris*) still found in northern Scotland (Corbet & Southern 1977:379). Other carnivore specimens may derive predominately from domestic dogs and cats, but (on the Scottish mainland) a few could be from foxes or wolves (Corbet & Southern 1977:311, 315; Pennie 1982b:119, 124).

As discussed above, hare identifications from the Brough of Birsay are suspect and probably refer to intrusive rabbit bones (Rackham 1989:MF4G6). Setting these identifications aside, hare was only recovered as 18 specimens from an articulated partial skeleton at Freswick Links (Gidney forthcoming). Rabbits, which may have been introduced to Britain in the Norman period (Clutton-Brock 1981:146), probably represent intrusive burrowing in all cases. They infest the coastal sand deposits in which most of the sites under consideration lie.

As Allen (1995:Section 4.1.5) has argued, the economic importance of whales could be substantially underestimated by their limited zooarchaeological record.

Ethnohistoric analogy suggests that they were butchered at the kill site (Larson 1935:126-127). It is unlikely that bones removed to a settlement (incidentally or for craft activity) would adequately represent the potential value of even a small whale in terms of meat and oil - potentially usable for subsistence, lighting and exchange (Dennis et al. 1980:50; Fenton 1978:548). There is little hope of resolving this issue in any definitive way. The paucity of whale bones from Viking Age and Late Norse middens neither confirms nor denies the possibility that whaling was a substantial source of wealth. One route for future investigation may be the ethnoarchaeological study of recent whaling settlements in Faroe. This approach could provide analogs of value for interpreting the protohistoric data (see Allen 1995:Section 4.2.1 for useful application of a similar study).

Seals present the same problem as whales, although their smaller size (particularly if pups) is less inconsistent with the transportation of complete carcass portions to a settlement (e.g. Rackham 1989:247). Their poor representation at virtually all sites may thus be a realistic reflection of small scale exploitation. In recent centuries, seals were used for hide, oil and meat (Fenton 1978:524-525). It may be that they were sought on a very small scale for similar purposes during the Viking Age and Late Norse Period. This assessment does need qualification, however, in light of Platt's (1956:214-215) report on the fauna from Viking Age and later Norse deposits at Jarlshof. Seal bones were "in places preponderating over the domestic relics considerably" (Platt 1956:214). If this pattern is real, Bigelow's (1985:120; 1989:190) suggestion that it may relate to ownership of seal pupping grounds is probably apropos (see Larson 1935:397). Given the anomalous position of Jarlshof *vis-à-vis* all other assemblages from the earldoms, however, it is not inconceivable that the abundance of seal bones partially reflects bias of some sort in the recovery or curation of bone.

In summation, it would appear that hunting probably contributed very little in quantitative terms to the wealth of the settlements considered. Two possible exceptions include whaling, regarding which conclusions remain uncertain, and seal hunting, which may have provided valued resources only to households with authority over key pupping grounds. Deer remains, many of which must represent imported antler or labour intensive hunting expeditions in Caithness, may have played an important social role as symbols of wealth. It is unlikely, however, that they significantly contributed to its acquisition.

5.9 Collecting

A wide variety of natural products - including (among others) stone, driftwood, peat, turf, berries, edible plants, seaweed and shellfish - were probably collected from land and shore in the Viking Age and Late Norse earldoms (Andrew 1994:120-144; Allen 1995:Table 26). That they were perceived as wealth is implied by sanctions in medieval and post-medieval law (in Iceland, Norway, Orkney and/or Shetland) protecting access to many natural resources. Driftwood (Fenton 1978:111), seaweed (Clouston 1914:81-83), peat (Fenton 1978:211), wild berries (Griffin 1994:522-523) and grass from natural pastures (Larson 1935:96-98, 398) were probably especially important. Driftwood served for fuel and building (see Table 5.8; Owen 1993:332). Seaweed was potentially important for fertiliser and animal fodder (see Table 5.8; Fenton 1986b:58-69; Simpson 1994:104). Peat was used for fuel and probably also for animal bedding and fertiliser (see Table 5.8; Simpson 1993:4). Wild berries served as food (see Table 5.8; Griffin 1994). Finally, grasses (Gramineae) - and probably also sedges (*Carex*) and short heath taxa - must have provided animal fodder (see Table 5.8; Fenton 1978:424; Zutter 1991). Shellfish, ubiquitous at both Viking Age and Late Norse sites (Allen 1995:Table 22), may also have been of considerable value. Although low in nutritional yield (Evans & Spencer 1977:215-216), they have served as fish bait and famine food in more recent centuries (Fenton 1986a; 1992).

Collected resources were fundamental for subsistence and must occasionally have been exchanged. A well known analogy from medieval Iceland is the attempt by Gunnarr to buy hay in *Njal's Saga* (Magnusson & Pálsson 1960:120-121). Nevertheless, the role of gathering as a source of wealth was probably manifest predominately in the activities it facilitated. Collected resources were necessary for arable agriculture, pastoralism and fishing as well as providing the necessities of food, heat and shelter.

5.10 Chapter Summary

This chapter has attempted to survey the primary activities by which wealth could be generated in Viking Age and Late Norse Orkney, Caithness and Shetland. In summation, it is possible to suggest that arable agriculture - particularly the cultivation of barley, oats and flax - was widely practiced. In light of symbolic evidence, such as sickles in graves and 'toy' quern stones, cereals were probably of considerable social significance. It is also likely, however, that routine drying of grain in kilns or over hearths has exaggerated its *quantitative* importance in the subsistence economy of the Norse earldoms.

Pastoralism was probably also a fundamental economic activity at virtually every site considered. Bones of sheep and cattle are particularly common, but the ubiquitous presence of pigs corroborates saga evidence for a society which valued meat as well as milk and wool. This conclusion is consistent with age at death profiles for cattle and sheep. Animals two-three years in age were killed rather than kept for their secondary products. Contrary to previous suggestions, there is little concrete evidence for the development of an intensive dairy economy in the Late Norse Period. There is also little evidence for an exclusive focus on wool production (contrary to the suggestions of Gelsinger 1981:114). The pastoral system was probably extensive, intended to produce a wide range of subsistence products, rather than specialised.

The substantial contribution of fishing to subsistence in both the Viking Age and Late Norse Period is demonstrated by the high proportion of fish bone at all sites for which inter-class comparisons are possible. All faunal assemblages from the earldoms suggest a primary focus on marine fishes of the cod family, Gadidae, while some also indicate small scale collection of anadromous salmonids and eels. Gadoid fish were probably caught by hand line during two distinct fisheries: one from (or very near) shore and the other in deeper water (but probably well within sight of land). An increase in the proportion of small saith in Late Norse deposits could be interpreted as evidence that larger taxa such as cod were being removed for export. It is more likely, however, that this difference relates to the use of better recovery procedures at many Late Norse sites.

Although wild and domestic birds may have provided food, feathers, oil and eggs they were probably a largely incidental aspect of Viking Age and Late Norse economic life. Domestic fowl and geese were kept, but apparently in very small numbers. Seabirds, such as the gannet, guillemot, razorbill, puffin, manx shearwater, cormorant and shag, are represented in virtually all of the faunal assemblages studied. However, they are not particularly abundant in relation to mammal and fish.

Zooarchaeological data suggest that hunting of animals such as deer, otters, seals and whales was probably also of relatively minor quantitative importance. However, this generalisation requires some qualification. Deer hunting may have been an elite activity of some social significance. Moreover, the apparent abundance of seals at Jarlshof may suggest that this taxon was locally important for households with legal rights to pupping beaches. Finally, the quantitative importance of whales may be underestimated by settlement and midden evidence if they were usually butchered at kill sites.

A variety of collected resources, such as stone, driftwood, peat, berries, grass, seaweed and shellfish, provided the basis for primary subsistence activities. They were raw materials for shelter and heat, fertilisers for arable agriculture, fodder and bedding for pastoralism and bait for fishing.

In summation, the wealth of both Viking Age and Late Norse Orkney, Caithness and Shetland "rested on a good many foundations" (to borrow words of Snorri Sturluson regarding Iceland) (Pálsson & Edwards 1976:76). Chief among them were arable agriculture (of great social, but perhaps modest quantitative importance), pastoralism (conducted to provide both meat and secondary products) and fishing (largely intended to catch marine cod family species). There is little firm evidence for chronological change in this pattern. Moreover, the current evidence yields little to support the possibility of gross economic differences between Orkney, Caithness and Shetland. Some inter-site variability is evident. Three striking examples are: the high proportion of fish bone at Robert's Haven and Freswick Links NCA, the high proportion of haddock and low proportion of seabirds at Earl's Bu and the dominance of sheep and saith at Beachview. These patterns, perhaps associated with local distinctions in site function or status, are discussed further in Chapters 7 and 9.

Chapter 6
Secondary Sources of Wealth

6.1 Introduction

In Chapter 5 it was suggested that the primary sources of wealth in Viking Age and Late Norse Orkney, Caithness and Shetland included five inter-related categories: arable agriculture, pastoralism, fishing, fowling, hunting and collecting (a 'catch all' category including the gathering of products such as peat, driftwood and seaweed). While wealth from these activities formed the ultimate basis of the Norse economy, it could be used in a variety of ways (either directly, or through the maintenance of labour) to acquire products with greater perceived value or utility from outwith the earldoms. Chapter 6 attempts to outline several processes by which this might have occurred.

Twenty six years ago Alan Small (1968:5) suggested that "in Viking times the North Isles were sitting in the main stream of Norse colonization". Since then, several authors have developed the hypothesis that the substantial wealth of Viking Age and Late Norse Orkney, Caithness and Shetland could be attributed to their position on the important western sea routes between Norway, Dublin and other Scandinavian colonies (e.g. Kaland 1982:93-94; Morris 1985:233-234, 1991:302; Small 1971:86; Wilson 1976:110-111). The earldoms probably served as staging points for voyages between Norway, Iceland, Greenland, Ireland, Scotland and England. While this argument raises an important point - Orkney, Caithness and Shetland should not always be perceived as geographical peripheries in the Scandinavian world - it is imprecise. It is necessary to ask in what ways the nodal position of the earldoms could be made to increase the wealth of their inhabitants.

Direct evidence regarding the Viking Age and the Late Norse Period is slim. Nevertheless, a combination of historical evidence, archaeological evidence and analogies from neighboring regions or later periods provides a list of possibilities. These include piracy, taxation, mercenary activity, tolls, provisioning, piloting and export trade (see Wilson 1976:110 for a brief introduction to several of the above). Each possibility will be discussed in turn. Emphasis is placed on the Late Norse Period, for which the largest body of data survives, but reference is also made to important Viking Age developments. In conclusion, the possible existence of a Late Norse trade in cured fish is raised. Subsequent Chapters, 7 and 8, critically assess the bioarchaeological evidence in favour of this possibility and attempt to isolate when it may have begun.

6.2 Piracy and Plunder

In a lecture in 1991 Barbara Crawford (1991b) suggested that the Viking Age earls of Orkney and Caithness were sustained by a plunder or military economy - a process recognised elsewhere in Scandinavia and Europe in the second half of the first millennium A.D. (Hedeager 1994; Reuter 1985). Defined simply, it involves the maintenance of a monopoly on the use of violence, and therefore power, by rewarding military followers with booty or tribute attained by piracy and conquest of rival groups (Reuter 1985:87-91). If 12th-13th century saga anecdotes can be extrapolated back to the Viking Age, the key to sustaining this system in Orkney was feasting - and thus access to pastoral and agricultural resources such as meat and malt (for the production of ale). Military clients were attracted and retained by maintaining them in grand style (e.g. Pálsson & Edwards 1981:56, 70, 124, 215).

It would be overly simplistic to suggest that overt military activity was the exclusive or even most important way in which wealth was generated by the rulers of Orkney and Caithness. As argued below, internal taxation (Section 6.3) and market trade (Section 6.8) were probably of equal or greater importance, particularly in the Late Norse Period. Nevertheless, some evidence for piracy and plunder does exist regarding the entire period of Scandinavian influence in Orkney, Caithness and Shetland.

The relative role of violence in the Scandinavian colonisation of the west is a fraught issue on which much ink has been spilt (e.g. Crawford 1981; Fellows-Jensen 1984:151; Morris 1991; Ritchie 1974; see Section 4.2). As Morris (1985:233; see also Blindheim 1978; Morris 1979) explains, however, "there was a considerable period of raiding, of which records in annals and insular material in western *Norwegian* graves provide incontrovertible evidence" (emphasis mine). Possible Viking Age evidence from *Orkney, Caithness and Shetland* includes whole and fragmentary metalwork of probable Celtic and Anglo-Saxon origin (e.g. Batey 1987a:106-107; Curle 1982:62-64; Hamilton 1956:128, 149). The most vivid example is perhaps the 8th century Celtic brooch of silver and gold from a Viking Age grave at Westness, Rousay, Orkney (Stevenson 1968:30; 1989).

Moving forward in time, it is possible that *some* of the hoarded silver from 10th and 11th century contexts in the earldoms also derived from plunder or tribute (Kruse 1993:196). Although it is argued below that much of this material is indicative of market exchange, some silver undoubtedly derived from tributary relationships. A likely candidate in this regard is 'ring-money', a term coined by Grieg (e.g. 1940:109), for plain penannular silver hoops of circular or lozenge cross-section which occur in abundance in 10th and 11th century Scottish hoards (Graham-Campbell 1976a:125; Warner 1976). Dolley (1981:175; see also Crawford 1987:134) has suggested that the distribution of finds in the Isle of Man (see Graham-Campbell 1983a) can be related to periods of Orcadian domination under earls such as Sigurðr Hlǫðvisson (d.1014). Certainly the 13th century Icelandic saga tradition ascribes the collection of tribute in Man and the Hebrides to his reign (e.g. Magnusson & Pálsson 1960:183-184; Pálsson & Edwards 1989:80-81).

Although piracy and plunder have occasionally served as the *sine qua non* of the Viking Age, they are not unknown in later centuries. Piracy, at home and abroad, is described as an activity of both earls and magnates in the 13th century *Orkneyinga Saga* (e.g. Pálsson & Edwards 1981:71, 145-146, 151, 171, 176, 185, 190, 193, 194, 196, 214-218; see also Sephton 1899:155-156). While the products of plunder are not always mentioned they included ships, money, cloth, cattle and malt. Later examples referring to plunder *of* the earldoms reveal both that this source of wealth remained fashionable in the 13th and 14th centuries and that its impact was not always positive. Hákon Hákonarson collected cattle, meal, cheese and other plunder or tribute in Scotland in 1263 (Dasent 1894b:346, 349, 355, 362). In 1312 an agreement between King Hákon of Norway and Robert Bruce of Scotland refers to

> certain injuries, losses, and displeasures to the men of the said King of Norway and their goods within his proper lands of Orkney and Shetland, by whatsoever malefactors of the said kingdom of Scotland these had been brought about and perpetrated, whether by invasion of the lands of Orkney or by taking of the noble man, Sir Bernard Peff ... knight, the appointed steward of the said King of Norway in those parts, who in addition to the loss of his own goods taken and carried away with himself, was obliged to redeem his life at the hands of the said malefactors with the moneys of his lord the King, which he had collected and uplifted in the parts aforesaid (Clouston 1914:3-4).

Later in the 14th century a shipment of salt destined for Caithness seems to have been intercepted by the Earl of Ross (Burnett 1878:308). Even as late as 1460 William Earl of Orkney and Caithness was excused from attendance at the court of King Christian of Norway due to the threat of raids from Ross (Clouston 1914:51-53).

Piracy must occasionally have been a lucrative occupation for both earls and magnates, continuing well beyond that period referred to as the Viking Age. However, its success was unpredictable and its ultimate impact potentially negative. Tributary relationships imposed on neighboring regions must have been advantageous for earls and their followers (although the earldoms also suffered similar relationships *vis-á-vis* Norway and Scotland at times, see Clouston 1914:3-4; Crawford 1982:72; Dasent 1894b:90, 149-150, 155, 346; Pálsson & Edwards 1981:32, 50-51, 84, 183, 223-224; Sephton 1899:155-157; Skene 1993[1872]:272; Stuart & Burnett 1878:19).

Conversely, local plunder and internecine conflict must have had a very mixed impact on the wealth of the earldoms. In this instance one can discuss the relative wealth of competing factions, but the overall economic result was probably negative. Sea piracy must also have competed heavily with the profits of market trade - the existence of which is a necessary precondition for this kind of robbery (see Sawyer 1978:28; Sawyer & Sawyer 1993:144).

6.3 Taxation

Plunder would appear to have played a significant role in both the Viking Age and the Late Norse Period. As mentioned above, however, this activity probably depended in the first instance on access to pastoral and agricultural resources such as meat and malt used to maintain clients by feasting. Although the existence of proprietary farms controlled by earls and magnates can be demonstrated or (in the case of the Viking Age) assumed (see Section 3.5.2), much of this produce may ultimately have derived from taxation of a subject population. Moreover, the products of taxation (at least in the Late Norse Period) provided rulers of the earldoms with wealth to undertake building projects and to sustain export trade.

No reliable evidence regarding taxation exists for the Viking Age. Saga anecdotes allegedly refer to payments demanded by Norwegian kings and Orcadian earls in the 9th and 11th centuries (Pálsson & Edwards 1981:32, 39). It is unlikely, however, that these can be accurate reflections of circumstances much earlier than the 12th century (see Section 3.2). Artifacts such as the ring-money introduced above could have been used for the payment of tax (Crawford 1987:134). This argument is difficult to sustain, however, in the absence of complimentary evidence. Other roles, including market exchange, are equally possible (see Sections 6.8.1 and 6.8.2 below).

In the Late Norse Period, the term taxation can be subdivided into four distinct categories: tribute, tax, rent and tithe. For the purposes of this study, tribute refers to irregular payments demanded by earls from polities outwith their direct control but under their (often temporary) military power. It is synonymous with plunder and has been discussed in Section 6.2 above. Tax (ON *Skat*) was a regular payment demanded by the earls . Although the origins of skat are obscure, it was a tax on land when the first detailed rentals of Orkney were compiled in 1492 and 1500 (Thomson 1987:119). It may date to the late 12th or early 13th century when regular annual taxation is first known in Norway (Andersen 1991). Rent was owed by tenants to earls, magnates, church officials and other land owners. The evidence includes saga anecdotes (Pálsson & Edwards 1981:163, 197), a single late 13th century document regarding Shetland (Johnston & Johnston 1907-1913:38-40), ecclesiastical records (Andersen 1989:21-22;

Johnston & Johnston 1909-1928:18-23), 15th-16th century rentals (Goudie 1904:171-185; McNeill 1901:325-327; Peterkin 1820; Thomson 1984; 1987:116-124) and (as analogies) medieval Norwegian laws (Larson 1935:89, 377-379). Prior to the 12th century, payments to churches (traditionally under private aristocratic control in Scandinavia) may also have enriched earls and magnates (Sawyer 1988:39; Sawyer & Sawyer 1993:110). In the 1100s, however, formal tithes were introduced in Norway and probably in the Scottish colonies which were also subject to the Archdiocese of Nidarós (Sawyer 1988:40). After this time, tithes were retained by local church officials (Crawford 1985b:28; Guðmundsson 1965:298-300), or (in a few instances) sent to Nidarós or Rome (Johnston & Johnston 1909-1928:3-4; Theiner 1864:112, 115).

The products of tax, rent and tithe are not always clear. The earliest evidence refers to ecclesiastical payments. A letter of Pope Innocent III of 1198 criticised the Bishop of Caithness for failing to collect (or perhaps keeping for himself) the gift of a penny per household per year which Earl Haraldr Maddaðarson had granted some years previously (Johnston & Johnston 1909-1928:3-4). The term penny could be a convenience of accounting, a phenomenon which is explicit in some later documents, but actual payment in coin is also possible. Although this particular payment was destined for Rome, it suggests that money may have been a medium of taxation (in its broadest sense) as early as the 12th century.

In 1222 a dispute regarding tithes of butter and possibly hay led to the murder of the Bishop of Caithness by a mob of angry free farmers (ON *Bœndr*) (Crawford 1985b:28; Guðmundsson 1965:298-300). The constitution of the cathedral of Dornoch, dating to several decades later, does not refer to specific products. However, it grants tithes and income (presumably rent) from lands in Caithness owned by the church to support 10 canons of the cathedral (Johnston & Johnston 1909-1928:18-23).

Crusade contributions from Caithness in 1274-1275 were recorded in currency values rather than in kind (Anderson 1981[1873]:lxxxiv; Theiner 1864:112, 115), but it is difficult to tell whether this represents a convenience of accounting. A similar problem exists for a record of income from several Orcadian churches in 1327-1328 (Cowan 1971:11). A reference to tithes owed by the Bishop of Orkney to Nidaros in the same year also uses monetary units. However, it adds that the Bishop's possessions were pledged for part of the sum (Gunnes & Kjellberg 1979:201-202).

The first detailed record of rent from the earldoms is a court document from Shetland dating to 1299. The rents discussed were in dispute, but included

> a mark of burnt gold for arable land from every pening-land; and as landskyld [rent of land] one mælir and a half from every mark burnt (Johnston & Johnston 1907-1913:39-40).

Regrettably this document is somewhat ambiguous. A mælir was a measure of both grain and liquids (Johnston & Johnston 1907-1913:39-40). Moreover, it is not completely clear whether the product so measured equaled "a mark of burnt gold" or was in addition to it.

The best evidence regarding both rents and taxes actually post-dates the Late Norse Period proper. A document from 1418 regarding lands of the Norwegian monastery of Munkeliv in Shetland mentions the payment of rent in butter and "Shetland wares" (possibly wool cloth, see Section 6.8.4 below) (Lange & Unger 1849-1919:Volume xii 123-124; B. Smith pers comm.). Additional information regarding skat and rent in Shetland comes from an imperfect mid-16th century copy of a document which may date to c.1500 (Goudie 1904:171-185; MacGregor 1984:7). It includes money (conceivably only a matter of accounting once again), butter, wadmel, skins and fatguid. The last is an ambiguous term which may mean butter or oil (Goudie 1904:176). If the latter, it is probably fish oil (see Section 5.6 above). Another relatively early record of taxation in Shetland dates to 1588. It includes wadmel, butter and oil, with no clear distinction between rent and skat (McNeill 1901:325-327).

The Orcadian rentals of Lord Henry Sinclair, from 1492 and 1500 have been studied for the light they throw on both 15th century and earlier patterns (Thomson 1984; Thomson 1987:119-122; Peterkin 1820). It is evident that skat was charged principally in butter and malt, with the former fixed and the latter dependent on the amount of land in cultivation in any given year. A third tax, called wattle, represented an obligation to supply the earl or his representatives with food and lodging. However, it had been largely converted into a money payments by the 15th century. The final tax, forcop, was highly variable and may represent a payment for new land brought under cultivation.

The final record of present relevance relates to lands in Caithness owned by the Bishop of Orkney (Andersen 1989:21-22). Although the document dates to c.1500, the properties were probably granted prior to formalisation of the Bishopric of Caithness early in the 13th century (Andersen 1989:13). Customary payments in the rental may thus have some antiquity. Both skat (suggesting that the original grant was from an earl) and rent are mentioned. The former explicitly included malt and silver. The latter was somewhat variable, but included cereal grain (only oats were mentioned by name, but general references could include barley), domestic fowl, straw, silver and "dew service," presumably labour.

In summation, there is direct evidence to suggest that taxes, rents and tithes were extracted as butter, grain (particularly malt), currency and hay in the Late Norse Period. Suggestive 15th and 16th century records add wadmel, oil, domestic fowl, skins and straw. There is some evidence for regional variability, with wadmel and oil possibly replacing cereal products in Shetland.

The purposes to which taxes and rents (and possibly also tithes) were put can be reconstructed to some degree. As suggested above, food products, particularly malt for ale, must have been important components of a 'feasting complex' through which both earl's and magnates maintained their clients and expressed their aristocratic status. The 12th or early 13th century author of *Orkneyinga Saga* thought it appropriate to suggest that the 11th century earl Þorfinnr Sigurðarson

> made something of a name for himself in Orkney by feasting his men, and others too, people of great reputation, on meat and drink throughout the winter (Pálsson & Edwards 1981:56).

Perhaps more historically reliable, in terms of chronological distance from the author, are two accounts regarding the 12th century magnate Sveinn Ásleifarson.

> This was how Svein used to live. Winter he would spend at home on Gairsay, where he entertained some eighty men at his own expense. His drinking hall was so big, there was nothing in Orkney to compare with it ... (Pálsson & Edwards 1981:215).

> He invited Earl Harald to a feast, welcoming him with a magnificent banquet, at which people had plenty to say about Svein's high style of life (Pálsson & Edwards 1981:216).

The income of tax and rent could also have served as commodities for export trade. The earliest direct evidence derives from c.1424 (when the local administrator, or foud, of Orkney exported grain), but this is probably a symptom of the poor historical record for earlier centuries (Clouston 1914:37; see Section 3.2 below). Taxation may also have been used to fund the construction of monumental architecture, such as Earl Rǫgnvaldr Kali Kolsson's ambitious project St Magnus cathedral (Pálsson & Edwards 1981:142).

6.4 Mercenary Activity

It is likely that some wealth in both the Viking Age and the Late Norse Period derived from direct or indirect payments for military service and political loyalty. The 13th century saga literature includes frequent allusions to payments of silver and gold objects or coins (e.g. Bibire 1988:228, 235; Dasent 1894b:366-367; Magnusson & Pálsson 1960:183; Pálsson & Edwards 1976:129, 236; Pálsson & Edwards 1981:87, 160). Other gifts, such as ships are also mentioned (e.g. Dasent 1894b:345; Pálsson & Edwards 1981:42, 58, 156). Much of this evidence, such as the chest of silver which Egil Skallagrimsson allegedly earned fighting in England (Pálsson & Edwards 1976:236), is of a literary nature with general rather than specific relevance to the earldoms. Nevertheless, several incidents from the more 'historical' king's sagas may represent events of immediate relevance to the Late Norse earldoms (see Section 3.2 for a discussion of sagas as historical sources).

Haraldr Sigurðarson's ill fated campaign of 1066 is one such example. He enlisted the help of the joint earls Páll and Erlendr and "gathered a large force" in Orkney (Magnusson & Pálsson 1966:141). While this recruitment may have entailed an element of coercion, it is unlikely that the participants expected to return from England empty-handed. Another is Hákon Hákonarson's campaign in the west of Scotland in 1263. While dying in Kirkwall on his return

> he took counsel for the wages-gifts to his body-guard, and he commanded that a mark of burnt silver should be given to each man of the body-guard; but half a mark to the guests and dish-swains, and the rest of his serving-men. Then he let all the furniture of his table be weighed that was not gilt, and so ordered that where pure silver fell short, then his table-plate should be given, so that all might have what was their fair due (Dasent 1894b:366-367).

Earlier in the same campaign King Hákon had given Earl Magnús of Orkney a ship (Dasent 1894b:345). While the intent was undoubtedly to facilitate the earl's immediate participation in Hákon's campaign, a ship constituted a useful means of production with which plundering, mercenary activity and trade could be conducted.

It is possible that *elements* of the 10th and 11th century silver hoards already mentioned owe their origin to mercenary activity (see, for example, Graham-Campbell 1993:180). Hoards such as Dunrossness and Caldale, which included a coin of Haraldr Sigurðarson (d.1066) and English coins of Cnut (d.1035) respectively (Graham-Campbell 1976:123; 1993:176-177; Grieg 1940:119; Stevenson 1966:xviii), are prime candidates. The role of Orcadians in Haraldr's campaign of 1066 has already been discussed, but it is not unreasonable to suggest that they also fought with Cnut in England. The *Anglo-Saxon Chronicle* records that 72 000 pounds in tribute was owed to the Cnut in 1018 (Whitelock et al. 1961). Given the substantial corpus of his English coins which found their way to Denmark, the several hundred which appear in Orkney are not surprising (Galster 1970).

An element of mercenary pay in northern hoards is not inconsistent with market exchange - which was probably one *raison d'être* of 10th and 11th century silver (see Section 6.8.2 below). Payment in coin, as opposed to silver objects which might serve as symbols of 'office' or favour, suggests that mercenaries had the opportunity to spend them. This is a simple, but fundamental, point which has been overlooked to some extent by previous discussions of 'plunder' economies (e.g. Reuter 1985).

Mercenary activity was undoubtedly a source of much personal wealth, some of which may have returned to the Isles. It could conceivably have benefited several levels of society, from courtiers (e.g. Bibire 1988:228, 235) to earls (e.g. Magnusson & Pálsson 1966:141). However, large scale military service, on expeditions such as Haraldr Sigurðarson's invasion of England, were relatively isolated events. Moreover, they were as likely to have cost the local population at all social levels (in the form of foodstuffs, labour and even bullion) as to have left a surplus of wealth. Hákon Hákonarson, for example, fined the people of Caithness in 1263 and boarded his retinue in the isles during the winter of 1263/1264 (Dasent 1894b:346, 365).

6.5 Shipping Tolls

It is tempting to see the imposition of tolls for passage as a potentially important source of wealth in the earldoms (Morris 1985:232; Kaland 1982:94; Wilson 1976:110). Certainly the example of the Store Bælt, Lille Bælt and Øresund tolls imposed by Denmark reveals the potential of such an exercise (Sawyer & Sawyer 1993:147; Smith 1984:11). The coastal position of the Late Norse castles of Caithness (Figure 1.2) could be interpreted as an attempt to control the coastal waterways of eastern Britain. Moreover, Morris (1985:232) remarks that the maritime focus of Earl Þorfinnr's settlement at Birsay implies an intent to control sea traffic.

The supporting historical evidence is suggestive. In one allegedly 12th century example, the magnate Sveinn Ásleifarson

> happened to go up to Lambaborg [possibly the predecessor of the 15th century Bucholly castle, see Batey 1987a:22; 1991a:32 and Figure 1.2b] with a few men and they saw a cargo-boat traveling south across the Pentland Firth ... Svein told his companions to come down to the ships with him and sail out to the cargo-boat, which is what they did, capturing it along with everything on board (Pálsson and Edwards 1981:185).

Although the result in this case was plunder, tolls could be enforced by a similar process of interception. Another incident involves a ship's crew which was instructed to land so that they might exhibit their wares to Earl Páll Hákonarson (d. c.1137) (Pálsson & Edwards 1981:137). As the vessel was in Eynhallow sound (between the islands of Mainland and Rousay), however, it is unclear whether Orkney was perceived as a staging point or a destination.

An early 13th century reference from *Sturlunga Saga* refers to the Hebrides rather than the Northern Isles, but is less ambiguous. The bishop-elect of Holar in Iceland was forced to land in the Scotland by poor weather while en route to Norway. Representatives of Óláfr, king of the Hebrides, claimed a landing toll in wool cloth. After disagreement that almost ended violently a fee of slightly less than half that requested was paid (Anderson 1990[1922]:358-360).

While the interception of passing shipping was possible, particularly given the vagaries of weather and the (sometimes exaggerated) medieval custom of coastal navigation (Marcus 1980:116-117), it seems unlikely that the imposition of tolls could have been consistently effective. Unlike the Danish examples, involving relatively discrete and narrow bodies of water, the islands of Orkney and Shetland provide a multitude of paths and channels through which a knowledgeable crew might avoid attempts to limit and tax their passage. Tolls could have been easily imposed, however, if ships were obliged to collect provisions or local pilots. Moreover, customs dues could be collected from merchants trading in the earldoms. These caveats are discussed further below.

6.6 Provisioning Shipping

Provisioning passing shipping is likely to have played an economic role at several levels of society. Typically, the available evidence is exclusively for the Late Norse Period and later. Analogies from the post-medieval period are particularly revealing. It is likely that Shetlanders were provisioning Hanseatic merchants from the beginning of their direct trade with the islands c.1416 (Friedland 1973; 1983:88, 93). This tradition continued with the growth of the Dutch herring fishery off Shetland in the 16th and 17th centuries (Goodlad 1971:83). The scale of this exchange can be gauged by the fact that the occupants of Shetland spoke Dutch as well as Norn and English in 1700 (Brand 1883[1701]:104). One route from England to Iceland during the 17th or 18th century passed between Egilsay and Rousay in the Orkneys (Sibbald 1845[1711]:9). It is arguable that this route was chosen partly to facilitate the acquisition of supplies. Moreover, Orkney and Shetland played an important role as the last provisioning stops of whaling, fishing, fur trading and other voyages to the

New World after the European explorations of the late 15th century (Finn 1989:19, 70; Thomson 1987:217-221).

The demand for provisions was met by both peasants and magnates. The foud (kings representative) in 17th century Shetland rented lodgings (including board) to Hanseatic merchants for their summer visits (Friedland 1973). Conversely, Low (1879[1774]:56) describes the provisioning of foreign shipping by "the people" of Orkney. One of the Orkney country acts of 1615, passed at Kirkwall to temper the newly introduced Scottish law to previous practice (see Barclay 1967:xxvi), is particularly revealing. It regards "sluggish and idle persones quha, leaveing servoice, gives them selfis to traffique and play the merchand and attendis the repairing of sh[ippis] and straingeris ..." (Barclay 1967:30; see also Shaw 1980:165).

Evidence for provisioning in the Late Norse Period is revealing if not plentiful. In one example attributed to the 1150s Árni, a Norwegian lodging in Orkney prior to a pilgrimage to Jerusalem, refused to pay for malt and animals he acquired from a tenant of the magnate Sveinn Ásleifarson (Pálsson & Edwards 1981:163). He was eventually killed by Sveinn for this transgression. This account suggests that provisioning could generate wealth directly for the peasantry. As in later periods, it was not exclusively controlled by earls and magnates.

Other evidence for provisioning evident in Late Norse sources refers to special circumstances - supporting the military retinue of Norwegian kings on campaign. Examples include Hákon Hákonarson's expedition of 1263 (Dasent 1894b:346-347; 365-366), Haraldr Sigurðarson's 11th century campaign against England (Magnusson & Pálsson 1966:141) and Magnús Óláfsson's 11th century voyage to annex the earldoms to his own rule (Pálsson & Edwards 1981:84). As discussed above, however, these instances are unlikely to have left a positive impact on the wealth of Orkney, Caithness and Shetland. More dramatic exploitation may also be assumed given the "Norwegians and Danes, sailing to the west and returning by way of Orkney, [who] often came ashore there to plunder the headlands" mentioned in *Orkneyinga Saga* (Pálsson & Edwards 1981:49).

It is possible that provisioning had a threefold impact on the economy of the earldoms. The first is a direct increase of wealth by exchange on favourable terms. This wealth, as we have seen, may have benefited several levels of society. The second is the fact that provisioning requirements would bring ships into the power of earls or magnates, facilitating the collection of passage tolls. In this way, the problem of control raised above would be avoided. Third, imposed demands for provisions may occasionally have resembled plundering, with a concomitant negative impact on the wealth of the earldoms.

6.7 Piloting

Although evidence for the use of local pilots is lacking for the Viking Age, this was a common and necessary practice recorded in the 13th century and later. For example, pilots were sought in Shetland prior to Hákon Hákonarson's campaign (Dasent 1894b:342). They were also employed by Bremen merchants trading in Shetland in the 16th and 17th centuries (Friedland 1973). Given the extreme danger of the waters of the Pentland Firth, Orkney and Shetland this practice may have been common. The potential benefits of navigating with (and hazards of traveling without) a local pilot are shown in sharp relief by a 16th century incident. A ship used by the Earl of Bothwell in his flight to Shetland (following his implication in the murder of Queen Mary's prior husband) was closely pursued near Tingwall by Sir William Kirkaldy of Grange. A local pilot took the fleeing ship close to a sunken reef on which Kirkaldy's vessel foundered (Henderson 1985:194-5).

In later periods, piloting seems to have been organised on a somewhat *ad hoc* basis (e.g. West 1970:7-8; Withrington & Grant 1979[1791-1799]:22), perhaps providing a pleasant windfall for local farmers and fishers. It is impossible to know how this service might have been organised in the Viking Age and Late Norse Period, but the resulting wealth is likely to have been of similarly small scale.

6.8 Export Trade

6.8.1 Introduction

Direct trade of exportable 'commodities' is the final, and perhaps most important, way in which primary wealth could be manipulated to increase its perceived value. I use the term commodity (defined in the general sense as an article of trade; see Hodges 1989b:198-199) explicitly, accepting its connotations of market economics. This term is employed for two interrelated reasons. First, products such as wool cloth, grain and cured fish were probably sometimes perceived as media for trade rather than utilitarian items. The evidence for this must largely be culled from appropriate analogies given the paucity of direct information regarding Norse Orkney, Caithness and Shetland. The Icelandic perception of Wadmel (woolen cloth), the island's primary export during the Commonwealth period, provides an excellent example. It served as a legally controlled standard of value in trade negotiations (Gelsinger 1981:12-13). Closer to our area of interest, grain was exported from Orkney despite local subsistence shortages in the first quarter of the 15th century (Clouston 1914:37). This example illustrates an implicit distinction between subsistence resources and commodities. Moreover, it illuminates an important corollary of this distinction - its dependence on social divisions. The acting ruler of Orkney, David Menzies, in whose power the decision to export grain lay, acted against the wishes of at least one segment of Orcadian society which later complained to earl and king (Clouston 1914:37,40-41). The ultimate expression of this distinction between subsistence resources and commodities (and its social contingency) is perhaps the Shetlandic fishing stations of the 18th and 19th centuries. Cod, ling and torsk caught and dried by fishermen were exported by landowners, leaving the peasants to eat fish heads, livers and roes (Fenton 1978:581).

The second justification for using the term commodity is an assumption that some inhabitants of Late Norse (and possibly Viking Age) Orkney, Caithness and Shetland were at least occasionally engaged in a market economy. A market economy, adopting Hodges' (1989a:15) acceptance of Bohannan and Dalton's formulation (1962:1), is defined as "the determination of prices by forces of supply and demand regardless of the site." Expressed simply, it refers to exchange in which material profit is an intrinsic (although not necessarily paramount) motive (Hedeager 1994:137). In addition to this key premiss, market exchange may also be characterised by ancillary attributes such as the market place, merchants and currency (defined as a standardised medium of exchange) (Hodges 1989a:15, 108-109, 162-166; Pounds 1994:115). It can be contrasted with a variety of postulated exchange systems, all of which are allegedly motivated exclusively by asymmetrical or symmetrical social negotiations.

A survey of non-market economic systems is both unnecessary and impractical in the context of this thesis. The relevant literature is voluminous (e.g. Callmer 1977; Doherty 1980; Duby 1974; Durrenberger 1988; 1991; Earle 1991a; Earle & Ericson 1977; Ericson & Earle 1982; Gaimster 1992; Gerriets 1985; Grierson 1959; Hårdh 1978; Hedeager 1992:234-238; 1994; Hodges 1978; 1988; 1989a; 1989b; Huggett 1988; Jankuhn 1982; Kruse 1993; Parker-Pearson 1984; Polanyi 1963; 1978; Reuter 1985; Sawyer 1978; 1986; Skovgaard-Petersen 1981; Wallace 1987; Wilson 1982). Nevertheless, it will be useful to briefly address three common models. The first - described by terms such as military economy, plunder economy and expropriation - has been briefly mentioned already (Section 6.2). It is essentially characterised by the forceful acquisition of wealth which is subsequently redistributed to retainers (often, but not always, in the form of prestige goods) (Crawford 1991b; Durrenberger 1991:18; Hedeager 1994:133-138; Miller 1986; Miller 1990:70-78, 104-105; Reuter 1985). The second, variously termed taxation, mobilisation, redistribution and staple finance, is usually conceived as the institutionalized flow of wealth to a power holding group or individual (frequently including utilitarian products) (Byock 1993:222; Earle 1991b:3; Hodges 1989a:14-15, 108, 197; Lee 1990:238, 241-242; Smelsner 1959; see Section 6.3 above). This wealth typically supports an infrastructure with socially accepted functions. However, the altruism with which products and services are subsequently redistributed varies tremendously (see Lee 1990:241-242). The third model, described as gift giving or reciprocity, involves the negotiation of social relationships among equals or near equals (Durrenberger 1991:17-18; Hedeager 1994:130-133; Hodges 1989a:14-15; Miller 1986; 1990:77-78, 104-105).

While models of exchange are ideal categories, to which particular transactions are likely to deviate significantly, market trade has been widely accepted as a meaningful development concurrent with (and partially responsible for) important medieval social changes in northwest Europe (e.g. Callmer 1977:179; Duby 1974:257-270; Hedeager 1994; Hodges 1989a:105, 197; 1989b:194-202; Randsborg 1980:8-10, 1991:181-182). The relevance of market exchange to Europe generally between the 11th and 15th centuries has been well established - with the 13th and 14th centuries sometimes referred to as a "commercial revolution" characterised by merchant organizations, credit arrangements and formal governmental regulation (e.g. Pound 1994:108, 122-123, 407-442). Moreover, Richard Hodges and others have suggested that the development of market trade in Scandinavia is an earlier Viking Age development - a corollary of 10th century state development (Callmer 1977:179; Hodges 1989a:192; but see Gills & Frank 1993:174-176 for a holistic alternative view).

Hodges' argument is not without weakness - it owes its basis, for example, to simplistic models of unilineal evolution. Hodges draws heavily on Service's (1962; 1971) tired evolutionary categories the chiefdom and state, assuming that the latter is inextricably associated with market exchange (Hodges 1989a:105, 186-187, 197). The naiveté of these models is eloquently expressed by Trigger (1989:289): "The neo-evolutionism that developed in the United States in the 1960s was yet another attempt by anthropologists living in a politically dominant country to 'naturalize' their situation by demonstrating it to be the inevitable outcome of an evolutionary process ...". The enormous diversity of real societies ensures the existence of paths which diverge from those predicted by social Darwinist schemes (see Rindos 1984 for a detailed critique of the notions of 'directionality' and 'progress' in culture change).

Despite this caveat, Hodges' contribution to 'dark age economics' is useful. He explicitly illustrates the development of market exchange and demonstrates its direct association with the socio-political development of towns and kingdoms. His use of a problematic evolutionary paradigm can be tacitly ignored, although fundamental reassessment of his conclusions is inevitable in the long term.

Having suggested that market trade may be an appropriate model for Late Norse (and possible Viking Age) exchange it is necessary to address a dissenting voice. In the context of Iceland, Durrenberger has suggested that the Commonwealth period (10th - 13th centuries) was characterised by exchanges conducted exclusively to secure or manipulate social obligations (1991:17-18). Using anecdotes from the Icelandic family sagas as his source material, Durrenberger (1991:14, 17) suggests that wealth "was accumulated and lost in social maneuver, not through trade." While he does not suggest that this model is necessarily applicable throughout the North Atlantic region, it deserves attention.

Durrenberger makes an important point which may also be relevant to Orkney, Caithness and Shetland. The *Orkneyinga Saga* describes numerous 12th century transactions characterised by the logic of symmetrical reciprocity, asymmetrical redistribution and plunder. For example, reciprocal feasting and gift exchange among equals and near equals is clearly illustrated in the relationship between earls such as Haraldr Maddaðarson and magnates such as Sveinn Ásleifarson (Pálsson & Edwards 1981:216; see also Pálsson & Edwards 1981:147, 99-100, 123, 138, 161, 197). Conversely, relationships between earls or magnates and their subjects were characterised by taxation followed by redistributive feasting and gift giving (e.g. Bibire 1988:228, 235; Pálsson & Edwards 1981:70, 163, 185, 188). It should be noted, moreover, that this redistribution was probably limited to a select few - principally military retainers (e.g. Bibire 1988:228, 235; Pálsson & Edwards 1981:56, 160, 215). Lastly, exchanges characterised by violent expropriation of plunder were also commonplace (see Section 6.2 above).

While Durrenberger's argument is sound in some regards, it fails to address the possibility that different categories of exchange are not mutually exclusive. While reciprocal, redistributive and expropriative exchange occurred in Late Norse Orkney and Caithness, this does not eliminate the possibility of more prosaic market trade. It can be found in 14th century charters and in the *incidental detail* of saga accounts (see below). Market transactions seem to have been less desirable narrative themes than plunder, feasting, gift-giving and the intricacies of social relationships in general. This is not surprising given the primary role of the saga in Scandinavian society - to entertain (Foote 1984b:47-55; Magnusson & Pálsson 1960:25).

The degree to which different categories of exchange coexisted in Viking Age and/or medieval Scandinavia is clearly illustrated in studies by Hedeager (1994), Miller (1990:104-105) and others (e.g. Ingimundarson 1992:222; see Gaimster 1992:21-23 for a discussion regarding Britain). As Hedeager expressed it, "In traditional Iron-Age society, Gunnar [a protagonist of *Njal's Saga*] would have asked for the hay he needed as a gift; in medieval society he would ask to buy it for money. It was only in the Viking Age that he could reasonably try both" (1994:145). Durrenberger's contribution has been to illustrate that this economic syncretism continued to play a role in later centuries.

It is not enough, however, to accept that reciprocal, redistributive, expropriative and market exchange coexisted. In Late Norse (and possibly Viking Age) Orkney, Caithness and Shetland they were probably inextricable facets of a single system. Market exchange has frequently been characterised, implicitly or explicitly, as "neutral", or exempt from social implications (Durrenberger 1990:17-18; Hedeager 1994:101). However, the 'profit motive' cannot be disentangled from the web of social aspirations and negotiations described by Durrenberger. An example from the 13th century *Bandamanna Saga* unites Orkney and Iceland in this process (Porter 1994:5). Odd sailed from Iceland to Orkney where he bought malt and grain. He returned to Midfjord to prepare his wedding at which many prominent people were feasted - presumably with ale and bread manufactured from his Orcadian purchases. Moreover, "everyone was sent on their way with fine gifts" which "confirmed their friendship" (Porter 1994:111-112). Odd's participation in market exchange provided the wealth with which to manipulate social relations to his advantage. If the grain had been purchased using wealth from plunder and rent - a realistic possibility - all four categories of exchange would be represented.

This coexistence of market and alternative patterns of exchange was probably not an unusual phenomenon. In an immediately relevant example, the 12th century earl of Orkney, Rǫgnvaldr Kali Kolsson, gave gifts such as a gold-inlaid spear and ships to his followers and received honorary accolades such as hoard-diminisher (*hodda ryrir*) and gold giver (*sunda logs sveigir*) from aspiring and established members of his retinue (Bibire 1988:228, 235; Pálsson & Edwards 1981:160, 144, 148-149, 206). The same earl traveled from Shetland to Norway with merchants and his father, Kolr, sent ships to buy provisions and weapons in England and Denmark (Pálsson & Edwards 1981:122, 129). Later in his reign Rǫgnvaldr plundered his way to Jerusalem (Pálsson & Edwards 1981:164-182).

Direct historical evidence for the principal of market trade exists only for the Late Norse Period. It includes instances in which goods were sold or sought in Orkney or Caithness (or by people from Orkney and Caithness) in contexts where negotiating social relationships was not the sole motive. Records of attempted or successful transactions include the sale of subsistence provisions (Pálsson & Edwards 1981:163, 167) and land (Clouston 1914:10-15; Dasent 1894a:369; Pálsson & Edwards

1981:147). It is also tempting to interpret saga passages such as "... he rushed single-handed into a tavern where Thorarin was drinking ..." in Kirkwall as evidence for the sale of drink and perhaps lodging for profit (Pálsson & Edwards 1981:208; see also Pálsson & Edwards 1981:56).

The sale of land is perhaps the best evidence of an entrenched market principal. One might expect it, more than moveable goods, to be embedded in a web of social obligations. An element of this embeddedness is evident in Late Norse and subsequent sources. Eleventh and 12th century Norwegian law (and later records of Orcadian law) did demand that inherited land could only be alienated from a kin group in the event of extreme necessity (Robberstad 1983:49-50; Thomson 1984:139). Nevertheless, evidence for the purchase of land exists and it seems clear that the phrase "in myn urgent necessite" which occurs in 15th century Orcadian charters was somewhat of a formality (e.g. Clouston 1914:194, 196; Robberstad 1983:60). The evidence for sale of land includes both saga anecdotes (Dasent 1894a:369; Pálsson & Edwards 1981:147), allegedly referring to the reigns of Earls Sigurðr Hlǫðvisson (d.1014) and Rǫgnvaldr Kali Kolsson (d.1158), and 14th century charter evidence (e.g. Clouston 1914:10-15). Two charters are particularly illuminating. One transaction of 1329, regarding land in South Ronaldsay, was to be settled by the payment of 25 pounds in "English coins or in good coins of old validity" (Clouston 1914: 10-11). Another charter of 1360 conveyed land in Shetland, to Lady Herdis Thorvald's daughter "so that she may give or pay or sell it as she likes" (Clouston 1914:14). The use of currency in these transactions also raises the issue of coinage recovered from archaeological contexts. This evidence, however, will be discussed in Section 6.8.2 below.

Having introduced the concept of market trade it is now possible to discuss the export of commodities from Viking Age and Late Norse Orkney, Caithness and Shetland. Historical and archaeological evidence illustrates the existence of merchant voyages and, in the Late Norse Period, of market towns or *ad hoc* markets. The evidence in favour of long range market trade in the Viking Age is exclusively archaeological and slightly more ambiguous.

6.8.2 Merchant Traffic

The earliest historical evidence for merchant voyages to and from the earldom's derives from *Bandamanna Saga*, *Njal's Saga*, *Orkneyinga Saga* and *Sverri's Saga* (Magnusson & Pálsson 1960; Pálsson and Edwards 1981; Porter 1994; Sephton 1899). *Bandamanna Saga* attributes a trading voyage between Orkney and Iceland to the 11th century, although its account may relate more closely to the 13th century in which it was composed (Gelsinger 1981:119; Porter 1994:5, 110). A passage in Njal's Saga (composed c.1280) in which "the Njalssons sailed from Orkney to Norway and spent the summer trading there" is similarly ambiguous (Magnusson & Pálsson 1960:9, 188). Direct references to merchants or trading ships in *Orkneyinga Saga* include 12th century voyages between Shetland and Norway, Orkney and Scotland, the earldoms and Bergen and Norway and Orkney (Pálsson and Edwards 1981:122, 152, 155, 183). Indirect evidence which may imply trading activity includes references to Orcadians in Norway in the late 11th century (Pálsson and Edwards 1981:82), Orcadians in Grimsby, England, in the early 12th century (Pálsson and Edwards 1981:109) and ships prevented from sailing from Shetland to Norway in the mid 12th century (Pálsson and Edwards 1981:193). One event in *Sverri's Saga*, tentatively dated to 1186, is particularly suggestive evidence for trade between Shetland, Orkney and Norway (Power 1990:21; Sephton 1899:129). In a speech against drunkenness brought on by the import of German wine, the saga composer had Sverrir thank those regions which brought goods beneficial to Norway.

> We desire to thank the Englishmen who have come here, bringing wheat and honey, flour and cloth. We desire also to thank those who have brought here linen or flax, wax or caldrons. We desire next to make mention of those who have come from the Orkneys, Shetland, the Faereys or Iceland; all those who have brought here such things as make this land the richer, and we cannot do without. But there are Germans who have come here in great numbers, with large ships, intending to carry away butter and dried fish, of which the exportation much impoverishes the land; and they bring wine instead, which people strive to purchase, both my men, townsmen, and merchants. From that purchase much evil and no good has arisen ... (Sephton 1899:129).

Thirteenth century historical evidence is modest, excluding the saga references already mentioned which allegedly refer to earlier periods. Nevertheless, *Sturlunga Saga* records that an Orcadian merchant with a cargo of barley meal and malt stayed with Snorri Sturluson in Iceland c.1203 (Gelsinger 1981:118; McGrew 1970:129-130). Ships did pass between Norway and Orkney; Earl Jón Haraldsson and Bishop Bjarni Kolbeinsson attended court in Norway (Dasent 1894b:42, 45, 77, 90, 134) and messages were sent between Norway and Orkney (e.g. Dasent 1894b:27, 149, 217). It is uncertain, however, whether these voyages were conducted on merchant ships or private vessels. Diplomatic voyages were also common between Man, the Hebrides and Norway (e.g. Dasent 1894b:134, 152, 265-268, 286, 339-340), perhaps suggesting that southwestern trade routes were also maintained. It can be assumed that trade contact between Norway and *Shetland* was particularly close during this, and the succeeding, century. The archipelago was taken under direct Norwegian control after 1195 (Crawford 1985a:144; Sephton 1899:155-157; see Section 4.5). This connection is confirmed by legal evidence regarding Shetlandic trade with Norway from the late 13th and 14th centuries (Friedland 1973; Goodlad 1971:68). Regarding trade with Scotland, it is relevant that King Alexander II (d.1249) addressed a brieve to the people of Moray and Caithness giving protection to a ship of the convent of Scone (Johnston & Johnston 1909-1928:1; 12-13).

During the 14th century, an annual render of corn and wine was made to St Magnus Cathedral from Aberdeen (Crawford 1982:63; Ditchburn 1990:75) and the Bishops of both Orkney and Caithness depended on burgesses of Aberdeen to convey their annuities to them (Ewan 1990:129). Moreover, the Earl of Caithness used a burgess of Edinburgh as a financial agent (Ewan 1990:133). These contacts imply the existence of trade links between the earldom's and the burghs of eastern Scotland.

A direct reference to trade with Scotland of particular reference to this study involves the purchase of 15000 'hard' (dried?) fish, *durorum piscium*, from Symon, falconer of Caithness in 1329 (Stuart & Burnett 1878:239). Moreover, an edict of King David II of Scotland from 1367 forbade travel to "the lands or harbours of Orkney unless for travel, merchandise or other peaceful business." (Crawford 1982:69-70). Crawford (1982:69-70) argues that this edict was in response to depredations in the north by the earl of Ross. A shipment of salt to Orkney in 1368, further evidence for merchant activity, was interfered with by this earl (Burnett 1878:308). Slightly later, in 1383, a Norwegian ruling restricted trade with Orkney, Shetland and other western colonies to merchants capable of assembling considerable wealth - 15 "forngild" marks (Christensen 1985:257).

It is known that tribute was conveyed from Orkney to Norway in the 14th century (see Section 4.5 above). It is ambiguous, however, whether this activity paralleled market transactions. The agreement mentioned in Section 6.2 above between King Hákon V of Norway and King Robert I of Scotland (and witnessed by Magnús Earl of Orkney and Caithness) records the kidnapping of a Norwegian steward by Scottish malefactors and his ransom with "the moneys of his lord the King, which he had collected and uplifted in the parts aforesaid" (Clouston 1914:3-6). Later, in the 1350s, Duncan Anderson wrote to the people of Orkney pressing the claim of Alexander of Ard to the earldoms of Orkney and Caithness and telling them to stop sending their dues to Norway (Crawford 1982:72).

The *archaeological* evidence for export trade in the Viking Age and Late Norse Period is predominately the material detritus of *imported* products. The movement of items over long distances does not necessitate trade in the market sense (e.g. Huggett 1988:89-94). Nevertheless, it is a logical corollary of such a trade. In discussions of the economy of Norse Shetland, Bigelow has postulated that the Late Norse Period, and the 12th century in particular, was marked by an influx of wheel made pottery, antler combs, metalwork and whetstones (1989:188-190). Broadening the focus to include Orkney and Caithness in both the Viking Age and Late Norse Period, imports of non-metallic ornaments, wood, steatite and currency can be added to this list (Batey 1987a:107; Batey et al. forthcoming d; Graham-Campbell 1993:184; Metcalf 1977:28, 30; Stevenson 1986:340-341).

The presence of these products in major Viking Age and Late Norse archaeological assemblages is tabulated in Tables 6.1 and 6.2. It is a qualitative rather than quantitative comparison as many of the sites are published only in preliminary form (indicated by *p*). The absence of an item cannot be given great significance for the same reason, except perhaps for the fully published assemblages. Tables 6.3 and 6.4 represent an attempt to separate the Late Norse Period into its two subdivisions for the few sites or artifacts which can be closely dated.

In all four tables, a single asterisk indicates the presence of one or more items which could be imported - such as whetstones or wood charcoal from non-native taxa. Two asterisks refer to items which are likely to be imported based on morphological similarity to cognate items known to be manufactured in other regions such as Norway, Germany and the kingdom of Scotland. Examples include wheel made pottery and (in Caithness where deer occur locally) antler combs. Three asterisks are employed in cases where an item can be confidently ascribed a foreign origin. They indicate materials which have been the subject of scientific provenancing studies and objects manufactured from non-local materials such as amber. Cases which do not follow these rules, or are otherwise exceptional, are indicated on the relevant table.

Steatite, in the form of raw material and (more commonly) vessels, spindle whorls and weights, was a ubiquitous import in Viking Age Orkney (e.g. Batey 1986:333; Batey 1989a:191, 199; Batey 1993a:26; Batey & Morris 1983:99-103; Curle 1982:67, 71, 80-81; Gelling 1984:19, 23-24; Hunter 1986:189, 194; Hunter & Morris 1982:129-131; Hunter et al. 1993:280). It also occurs in Late Norse (specifically LN1) Orcadian sites where it was used for the same objects and for baking plates (e.g. Batey 1993a:26; Curle 1982:84; Hunter 1986:189, 192, 194; Hunter et al 1993:280; Kaland 1973:85, 88, 99; 1993:309; McGavin 1982:419; Batey 1986:333-334; Batey et al. forthcoming b; forthcoming c; forthcoming d). Steatite was also found at Freswick Links (Batey 1987a:153-161) and Reay (Grieg 1940:22) Caithness. While this material could be derived from sources on the Scottish mainland, an origin from known Norse quarries in Norway or Shetland seems more likely (Ritchie 1984:65-66). Steatite from Viking Age and Late Norse Shetlandic sites, (Bigelow 1984:90-95; Crawford 1985a:150-151; Hamilton 1956:113, 134-135, 141-145, 149, 150, 153, 157, 164-165, 173, 178, 180-185; Small 1966:243-244), may be local given the presence of ubiquitous sources and the discovery of quarry sites in the archipelago (Buttler

1989:193, 200-202; Ritchie 1984:66-73). Some, however, may also have been imported. A self standing lamp found near the Biggins has parallels from medieval Oslo (Crawford 1985a:156). Moreover, an "hour-glass" type lamp which has parallels in Norwegian medieval towns was found at Sandwick (Bigelow 1989:190). It has also been suggested that finely finished round vessels from Underhoull were the imported product of professional craftsmen (Small 1966:243).

Birthe Weber (1992) has identified one Shetlandic steatite item which can be confidently attributed a Norwegian origin. Bakestones from Jarlshof, Sandwick and The Biggins are of a raw material (schistose soapstone) and style indicative of Norwegian quarrying and manufacture (Weber 1992:162). Weber suggests that the distinctive stone is found only in Hardanger, western Norway, where 29 quarries have been located. The earliest known examples of these items are from Gamlebyen, Oslo, dated to c.1100 (Weber 1992:163). Bakestones have also been recovered from Pool and Kirkwall, Orkney, but the ultimate origin of these examples remains to be investigated (Hunter et al 1993:280; Ross 1982:419). Some Orcadian baking plates could be imported from Shetland as a laminar steatite outcrop suitable for their manufacture (and a bakestone fragment!) were found at the Clibberswick quarry, Unst (Buttler 1989:202).

Attempts to fingerprint particular North American steatite sources using rare earth element distributions have met with some success (Allen 1975; Allen et al. 1978; Rogers et al. 1983). Regrettably, this method has not proven useful for Shetlandic material (Moffat & Buttler 1986:112-114; Ritchie 1984:77-82). The composition of a single outcrop is too variable. As Moffat and Buttler (1986:114) explain, "the variation at Cunningsburgh was as great as the total variation in Shetland." They recommend the whole rock comparison of reference specimens as the best route for future work - work which has not yet been systematically attempted.

Given these constraints, it is difficult to assess the likely origin of most steatite in Shetland, Orkney and Caithness. Local trade from Shetland or import from Norway are the most likely options given the established tradition of steatite working in these areas (Buttler 1989; 1991; Skjølsvold 1961:150-151, 154; Skjølsvold 1976). Direct trade from Norway is a distinct possibility. A degree of specialisation is evident in the Norwegian steatite industry, which supplied distant markets (such as Hedeby) from early in the Viking Age (Buttler 1991:231). However, a detailed study of manufacturing techniques, vessel forms and steatite sources would be needed before the source of the Orcadian material could be identified with confidence.*

Whether of Norwegian origin, or from closer to home, Buttler (1991:231) has suggested that:

> There is little reason to believe in a 'trade in steatite' among the Norse colonies as has sometimes been suggested in the past. The present evidence can easily be accounted for in terms of a few vessels and other oddments traveling as part of the household goods of settlers or occupying a minor portion of a trader's cargo.

This point is well taken. Much of the steatite from Late Norse contexts in Orkney and Caithness shows the careful curation of a rare resource. At Freswick, for example, broken vessel have been repaired or fashioned into weights and spindle whorls (e.g. Batey 1987a:153, 156-157). A similar pattern is also evident at Pool (Hunter et al 1993:280) and the Brough of Birsay (e.g. Curle 1982:84; Hunter 1986:189, 192, 194). It must be noted, however, that the absolute quantity of steatite is not minute. At Pool, for example, over 66 kg were recovered from Viking Age and Late Norse levels (Hunter et al. 1993:280). Moreover, steatite objects were also repaired and reused in Shetland where the raw material is abundant (e.g. Crawford 1985a:150-151; Hamilton 1956:182, 185). It would seem that the latter of Buttler's suggestions is the more apropos.

In the 12th and (particularly) 13th centuries wheel made pottery replaced steatite both in stylistic/functional terms and as the most ubiquitous import in the earldoms. Coil or slab built coarse wares which appear at the same time are probably local products (Batey 1986:338; Gaimster & Batey forthcoming; Jones 1995), but wheel made fabrics and forms can be matched to known Scottish, English or continental types (see Table 6.5). That pottery and steatite fit the same cultural category is vividly illustrated by attempts to make square pots (modeled after steatite vessels) from clay and spindle whorls (previously made from steatite vessel fragments) from pot sherds (Bigelow 1984:99; 1985:107; Hamilton 1956:187-188; MacAskill 1982:408; Batey 1987a:156-157; Batey & Morris 1983:99, 101).

The available evidence regarding wheel made pottery is represented in Table 6.5. Although a few sherds may date to the 1100s, most are probably 13th or 14th century in origin. Suggested trade links - based on the identification of pottery types such as Grimston ware, Scarborough ware, Scottish east coast white gritty type wares, Scottish

* After writing this chapter Andrea Smith informed me of her forthcoming study of Viking Age and Late Norse steatite from Pool, Orkney (Smith forthcoming). She suggests that the raw material and vessel forms are both consistent with a Shetlandic origin.

red wares, Low Countries red wares and Rhenish blue-gray ware - include England, boroughs of the Scottish kingdom, the Netherlands, Germany and Norway. Bigelow has suggested that the most likely proximate origin for much or all of this pottery is Norway (1984:101; 1989:188). These wares are common finds from medieval Norwegian towns such as Bergen and Trondheim (Blackmore & Vince 1994:32; Ditchburn 1990:74; Reed 1990:64-72). As Crawford (1985a:153-158) has noted, however, import direct from England and Scotland is not improbable. English links with Orkney may have been particularly strong in the 11th to 12th centuries (Cambridge 1988:111-113; Fernie 1988:158; Jesch 1993:235). Scottish political influence in the earldoms was also substantial from the 11th century if not before, particularly in the case of Caithness (Crawford 1982; Donaldson 1988:2; 1990:54; see Chapter 4).

At a general level of interpretation the issue of proximate origin is irrelevant. In either case the pottery suggests the existence of an import, and therefore export, trade. In detail, however, the difference is of considerable importance. It is obviously of relevance to the reconstruction of particular trade routes and cultural connections. Furthermore, it is of vital importance to our understanding of the process of ethnic syncretism or cultural replacement suggested by the gradual 'Scottification' of the earldoms - a process which culminated in social, linguistic, economic and political changes (Bigelow 1992:15-16; Crawford 1982; Owen 1993:336; Wainwright 1962b:120-121; Waugh 1986:99; see Section 4.5). Although I cannot hope to unravel this conundrum presently, it remains an important issue for future investigation.

Evidence for the import of antler, in the form of combs and (to a lesser degree) raw material in both the Viking Age and the Late Norse Period (Batey 1987a:225-228; 1989a:197, 200-201, 206-211, 214; Batey 1993b:157; Batey & Morris 1983:86, 89; Batey et al. forthcoming b; forthcoming c; forthcoming d; Bigelow 1984:103-106; 1985:122; Curle 1982:58, 75, 84; Gelling 1984:29, 36; Grieg 1940:81-82; Hamilton 1956:124, 134-135, 148, 150, 167-168, 179-180; Hunter 1986:181; Hunter et al. 1993:277; Ritchie 1976-1977:186-188; Thorsteinsson 1968:164-172), takes three forms. First, a local source of antler would not have been available in Norse Orkney and Shetland. These archipelagos have been without indigenous deer populations since early in the Viking Age or before (Berry 1985:133; Berry & Johnston 1980:130-131; Hunter et al. 1990:188; 1993:282; but see also Morris & Emery 1986:306). Although deer bones were nominally present in the Iron Age/Viking Age interface at Pool (Hunter et al. 1990:188; 1993:282), the number represented in published Norse assemblages is minute (see Table 5.5). Deer were available in Caithness, but it has been argued that the small antlers produced by the local red deer population (and found in Orcadian middens) were probably inappropriate for comb making (Batey &

Morris 1983:86; Rackham pers comm.). Thus, antler was transported to Shetland and Orkney, at least from Caithness, and might have been imported from further afield to all three regions of the earldoms.

Second, and potentially more definitive, is Weber's suggestion that Viking Age and medieval (i.e. Late Norse) combs from several sites in Orkney and Shetland were fashioned from reindeer rather than red deer antler (Weber 1992:159,161; Weber 1993). Viking Age combs (from Brough Road Areas 1 and 2, Buckquoy, Saevar Howe and Skaill, Deerness) and Late Norse examples (from Jarlshof and Sandwick) were identified as reindeer antler (Weber 1992:159, 161; 1993:166-170). As the post-Pleistocene survival of reindeer in Britain lasted only until c.8000 BP (Clutton-Brock & MacGregor 1988:32) this suggestion could provide tantalizing complementary evidence for the import of antler combs - presumably from Norway (Weber 1992:163). It must be noted, however, that there was some skepticism regarding the identification of worked antler to particular Cervidae taxa among zooarchaeologists at a meeting of the North Atlantic Biocultural Organisation in 1994.

Third, many combs recovered from Viking Age and Late Norse sites have close or precise parallels in Norway or other Scandinavian regions (Batey 1987a:225-228; 1989a:197, 200-201, 214; Batey & Morris 1983:86, 89; Batey et al. forthcoming b; forthcoming c; forthcoming d; Bigelow 1984:103-106; 1985:122; Curle 1982:58, 75, 84; Gelling 1984:29, 36; Grieg 1940:81-82; Hamilton 1956:124, 134-135, 148, 150, 167-168, 179-180; Hunter 1986:181; Hunter et al. 1993:277; Ritchie 1976-1977:186-188; Thorsteinsson 1968:164-172; Weber 1992; 1993; 1994). For example, "hog-backed" combs of distinctive type from Brough Road Areas 1 and 2 (Batey 1989a:200) and from early investigations at Freswick Links (Batey 1987a:226) probably date to the 9th-10th centuries and have parallels from Scandinavian centres such as Århus, Birka, Hedeby and Ribe. Other single sided composite combs from Freswick have 12th and 13th century parallels in Bergen and Oslo (Batey 1987a:225). Similarly, single and double sided combs from Late Norse Sandwick have parallels in Oslo, Lund, Viborg, Bergen, Trondheim and Ribe (Bigelow 1984:103-106). Evidence for comb making on a substantial scale is known from medieval Norwegian towns such as Kungahälla (Vretemark 1994). Given the lack of antler waste which can be specifically attributable to comb making in Orkney, Caithness and Shetland it seems likely that these items were imported (see Bigelow 1985:122).

Evidence for the import of metalwork is also suggestive. Many functional and ornamental examples from the earldoms have close or exact parallels in Scandinavia, Ireland or further abroad where manufacture has been demonstrated or assumed (see Callmer 1977:94-95 for a discussion of theoretical problems associated with differentiating areas of artifact production and trade). Ringed pins, oval, trefoil or equal armed brooches and mounts of various kinds are frequent finds in Viking Age settlement sites and graves (Batey 1989a:204, 212; Batey 1993b:148-159; Curle 1982:62-64, 78-79; Grieg 1940:15-25, 80-105; Hamilton 1956:127-129, 140-141, 149, 150, 152; Kaland 1993:312-317; Owen & Dalland 1994; Thorsteinsson 1968:164-172). Late Norse examples of potentially imported metalwork include an 11th or 12th century ringed pin of Irish type from Tuquoy and one (or possibly two) ringed pin fragments from Freswick Links (Batey 1987a:117, 144; Fanning 1983:330, 342; Owen 1993:327). A strap end with English Urnes style ornament and a copper bell with Scandinavian and English parallels was also recovered at Freswick Links (Batey 1987a:108, 123, 137, 146; Batey 1988:214-215; Vilhjálmsson 1992:312-313). Moreover, a silver inlaid bronze pin from the Upper Norse Horizon (LN1?) of the Brough of Birsay has parallels from Birka (Curle 1982:84).

Distinctive metal ornaments are less common LN2 finds. Bigelow argues, however, that copper alloy sheet metal (at least some of which represents vessel fragments) recovered from upper levels of Sandwick and Jarlshof may be of distant origin (1989:188; Hamilton 1956:165, 174, 181, 183, 185). While he suggests a German source (Bigelow 1984:214-215 and references therein), other options are also possible. Dublin is one example (Wallace 1987:203).

Copper alloy sheet has also been recovered from both Viking Age and Late Norse contexts in Orkney and Caithness. Viking Age examples include Brough Road Areas 1 and 2 (Batey 1989a:194), Saevar Howe (Batey & Morris 1983:94) and the Westness cemetery (Kaland 1993:314). Late Norse finds are from the Beachview Studio Site (Batey et al. forthcoming d), the Brough of Deerness (Batey 1986:341), Freswick Links (Batey 1987a:120-121, 145) and Westness (Kaland 1973:99). A small number of other Late Norse metal items, such as keys, may also have been imported (Bigelow 1984:111-112; 1989:188; see also Batey 1987a:125, 149; Hamilton 1956:129, 193).

While metal ornaments and sheet may have been imported, local manufacture cannot be *entirely* ruled out. Copper and iron ores are available within the earldoms (e.g. Mykura 1976:117-119; Tylecote 1986:125) and metalworking was not uncommon. A steatite mould for copper alloy pins and a crucible with copper alloy residue from Jarlshof phase V (LN1) provide direct evidence of some local manufacturing (Hamilton 1956:159-160). Tuyères, hearth bottoms, and other metal working bi-products were recovered from Phase 3 (LN1) of Hunter's excavations on the Brough of Birsay (McDonnell 1986a:198-203). Other evidence (probably relating to iron working) includes possible smithies at Jarlshof (Hamilton 1956:159), Tuquoy (Owen 1993:328), Westness (Kaland 1973:84, 100; 1982:93) and Freswick (Batey

1987a:93). Late Norse metalworking waste has also been recovered at the Brough of Deerness and the Beach View Studio Site (McDonnell 1986b:339; Batey et al. forthcoming d). A possible Norse metalworking complex identified by controlled surface collection at Lavacroon, Orkney, may also be relevant in this context (Batey & Freeman 1986:296-298).

X-ray fluorescence or other analyses could go some way towards confirming whether at least the raw materials for metal objects were imported (see Kruse & Tate 1992 for an example regarding Viking Age silver objects). Meanwhile, however, it is enough to say that communication, possibly with trading partners, was sufficient to spread objects *or* stylistic conventions across wide areas of the Viking Age and medieval world. It must be noted, however, that with the exception of the copper alloy sheet, much of this metalwork probably relates to the Viking Age and the earliest years of the Late Norse Period. I will return to this issue briefly in Section 6.10 below.

The possibility that whetstones were imported is similarly ambiguous. There is no doubt that these implements were widely traded in Viking Age and medieval Europe. Norwegian Ragstone (quartz-mica schist) hones, attributable to the Eidsborg quarries in Tellemark by petrology and K-AR dating, were particularly popular in medieval England and Scandinavia (Crosby & Mitchell 1987:484). Although Bigelow has emphasised the visual resemblance of schist hones from Sandwick, Jarlshof and Freswick to those quarried at Tellemark (1984:96; see also Batey 1987a:163-165, 185-186), a source very similar in appearance has also been located in Shetland (Crosby & Mitchell 1987:488-490, 502). Using thin-section comparison Crosby and Mitchell suggest that a hone from the Beachview Studio Site, Orkney, is actually derived from these Shetland Phyllites (Batey et al. forthcoming d; Crosby & Mitchell 1987:502). Furthermore, many hones were fashioned from materials such as sandstone which were probably of very local origin (e.g. Hunter 1986:189, 194-195; Batey et al. forthcoming d). While the whetstones mentioned by Bigelow, and other schist examples (e.g. Ross 1982:418), *may* be Norwegian imports, further provenancing studies are obviously called for.

Non-metallic ornaments provide some evidence for extra-regional contact, particularly in the Viking Age. Glass beads, found in graves (see Appendix 3.3) and settlements (Batey 1993a:26; Curle 1982:71, 83; Gelling 1984:19; Hamilton 1956:134, 136, 152; Ritchie 1976-1977:189, 199) are likely candidates for import given the degree to which these items circulated in Viking Age Scandinavia (Callmer 1977:94-104). A fragment of decorated glass, probably from a bowl or funnel beaker, has also been found at Saevar Howe (Batey & Morris 1983:106). Glass beads are less common in the Late Norse Period, but have been recovered from upper phases at Jarlshof

(Hamilton 1956:165, 181, 183). Amber beads (and fragments of unworked amber) have been found in Viking Age graves (Grieg 1940:38, 42, 45, 68, 77, 86, 87, 88) and in probable Viking Age contexts at the Brough of Birsay (Curle 1982:122), Brough Road Areas 1 and 2 (Batey 1989a:203), Earl's Bu (Batey & Harry pers comm.) and Freswick Links (Batey 1987a:166).

Possible 'jet' objects occur in Viking Age graves (see Appendix 3.3) and at the Brough of Birsay (Curle 1982:66-67). Although the most likely source of true jet is Whitby, these items are currently under study at the National Museums of Scotland and may prove to be of another, more local, material such as cannel coal or shale (Davis & Sheridan 1993; Sheridan pers comm.). A walrus ivory pendant from the Beachview Studio Site is unquestionably an import. Its burial was superficial, however, and its form is consistent with both a medieval Norse and an early modern Inuit provenience (Batey et al. forthcoming d). The latter is not unlikely given the substantial Orcadian role in more recent European exploration of the North Atlantic (Batey et al. forthcoming d; Thomson 1987:218-222).

An important trade in timber (from Norway and Scotland) for buildings and boats, known from 16th and 17th century historical sources (Baldwin 1986:193; Smith 1980; Smith 1984:32-35; Thowsen 1969), must have a Viking Age and Late Norse origin. As discussed in Section 2.3, the natural forest vegetation of Orkney and Shetland probably consisted of scrub woodland or thickets including only juniper, rowan, willow, birch, hazel and aspen. Driftwood could have provided a source of structural wood in some cases. Rights to driftwood were jealously guarded in post-medieval Orkney (Fenton 1978:111-112) and are known from medieval Icelandic sources (e.g. Dennis et al 1980:41; Pálsson & Edwards 1989:145). Moreover, some larch and spruce found in a waterlogged Viking Age pit at Tuquoy exhibited bore holes of a marine mollusk (Owen 1993:332). Nevertheless, it is unlikely that finished planks for the (in some cases elite) structures mentioned below or for the precise requirements of boat building (Small 1968:15) could be adequately supplied by this source.

Evidence for the importation of wood includes both surviving specimens from non-native taxa and archaeological features that imply the past existence of specialised timber products. Offcuts of pine and oak planks and a maple handle were recovered from a waterlogged Viking Age pit at Tuquoy, Orkney (Crone n.d.; Owen 1993:332). Pine and oak could have come from a variety of sources, but Norway is perhaps the most likely (Crone n.d.). The natural habitat of maple extends only as far north as England and southern Norway (Crone n.d.). Two possible timber chapels (Morris & Emery 1986:360; Owen 1993:323; Owen & Smith 1988:2), three or four boat graves (Batey 1993b:152; Kaland 1993:315-316; Owen & Dalland 1994) and implied structural timber at Pool

(Hunter et al. 1990:85; Hunter et al. 1993:276-277) and Earl's Bu (Batey 1993a:22-23) are also of definite or probable Viking Age date. The best Late Norse evidence includes a timber (pine) lined room or "stofa" radiocarbon dated to 1013-1156 A.D., large pieces of silver birch bark and a piece of cork (the last of Mediterranean origin), all preserved by waterlogging at The Biggings, Shetland (Crawford 1985a:142-143; 1991a:40-41; Dickson n.d.).

Wood from non-native taxa which *might* derive from imported timber has also been identified at virtually every excavated Viking Age and Late Norse site for which charcoal has been systematically studied (see Table 5.8 and Tables 6.1-6.4). Oak is particularly unlikely to represent driftwood as it has a high specific gravity (Dickson pers comm.). It is worth noting that the excavation of 15th to 16th century waterlogged deposits in Kirkwall has recovered offcuts from finished timbers of oak and pine, as well as worked pieces of hawthorn, alder and ash. All are likely to be imports (McCullagh 1982:416-417).

The final significant category of archaeologically recognisable Viking Age and Late Norse imports is precious metals as coins, bullion (ingots, hacksilver and ring-money), and jewelry (see Tables 6.6 and 6.7).* Objects of copper alloy or iron decorated with silver and gold are excluded from this list as they have been discussed above in the context of distinctive metalwork. The evidence falls into four broad categories. The first is two (or possibly only one) early 14th century coin hoards from Caithness (Archibald & Woodhead 1975:94; Metcalf 1977:28, 30). The second is three single coins which were probably lost in the 12th-14th centuries. The third category includes five mixed silver hoards dated to the 10th or 11th century by coin evidence, a single hoard of gold finger-rings tentatively dated to the 11th century, a single hoard of gold arm-rings broadly dated to the Viking Age and two hoards of silver objects which could date to any time between 925 and 1075 (Graham-Campbell 1976:126, 128-130; 1985:242-244; 1993:182, 184). These deposits, some of which date to the 11th century Viking Age/Late Norse transition, represent a Viking Age pattern of unrecovered wealth first represented in the earldoms by the Skaill find (deposited c.950) (Graham-Campbell 1976:127-130; Kruse 1993:199). The fourth category of imported precious metals is a group of single finds from Orkney, Caithness and Shetland - including coins, ring-money, rings and gold or silver fragments - dating to the Viking Age and the VA/LN transition (see Table 6.7).

Of the two 14th century hoards, one from Ladykirk, Duncansby Head, contained over 82 sterlings including 77 of English origin (Henry III, Edward I-II), 1 of Irish origin

* Note that this chapter was written prior to publication of Graham-Campbell's (1995) new corpus of Viking Age gold and silver. The reader is recommended to consult it for further information.

(Edward I Dublin) and 4 of Scottish origin (Alexander III, Robert I) (Archibald & Woodhead 1975:94). It was probably deposited c.1320 (Stewart 1973:135). The second, from Braemore, is of questionable provenance. Its attribution to Caithness is based on interpretation of a slightly ambiguous hand written label (Stewart 1973:138). It included at least 6 sterlings, two English (Edward I) and four Scottish (Alexander II and John), which were probably deposited in the early 1300s (Archibald & Woodhead 1975:94; Stewart 1973:139). In both cases the coins are entirely consistent with numerous contemporary hoards from mainland Scotland. Prior to the late 14th century, Scottish and English coins were economically interchangeable and English issues constitute 95% of the hoard material from throughout Scotland (Metcalf 1977:4).

Although two (or possibly one!) hoards hardly qualify as a cluster, they nevertheless demand some explanation. Ladykirk and Braemore are extreme outliers in a distribution of unrecovered silver hoards which otherwise ends in the 11th century (Graham-Campbell 1993:184; Kruse 1993:199). They are consistent, however, with a floret of unrecovered hoards of this period in mainland Scotland. Metcalf's explanation for this phenomenon, the dramatic political instability and warfare of early 14th century Scotland, is attractive in its simplicity (Metcalf 1977:11). Although the degree of 'Scottification' in Caithness at this time is a matter of some uncertainty (see Section 4.5), it seems reasonable that the threat of violence would affect 'Scot' and 'Scandinavian' alike. It is interesting to note in this context that the Cheynes, a pro-English faction during the Wars of Independence, had acquired as much control over Caithness as John, the earl of Orkney and Caithness, who favoured Bruce's party (Crawford 1982:67).

The single 13th century coin from Caithness, a lost silver penny of Henry III (d. 1272), was a surface find at Freswick Links (Batey 1987a:107). It is distinctive as one of only three single finds from the earldoms dating from the 12th to the 14th century. The remaining two are both from Shetland. An English short cross penny of Henry II (minted between 1180 and 1189) was found in 1994 at Upper Scalloway and a coin of Hákon V of Norway (reign 1299-1319) was discovered in the 19th century at Baltasound (Tait 1995). This tiny group provides the only link between the Viking Age and 14th century hoards. The gap in currency deposition may be partly explained by the relative paucity of excavated sites dating to the second half of the Late Norse Period (see Owen 1993:329). Nevertheless, most of the known 10th and 11th century silver hoards are products of casual discover (see Grieg 1940:110-111, 119-142 and references therein), suggesting that this negative evidence calls for a less facile explanation.

Kruse has suggested, based on this gap in hoard evidence, that the Scandinavian colonies of Scotland became silver poor after the mid-11th century (1993:200). This interpretation is not without problems. First, what stops in the late 11th century is the failure to recover hoards, not necessarily the use of silver for exchange. A comparison of English and Scottish hoards from the late 13th and early 14 centuries is illustrative in this regard. During the period of Scottish instability mentioned above,

> there are far more coin hoards of the Edwardian period from Scotland than there are from England, even though England was the wealthier country. The great increase over the number of thirteenth-century hoards from Scotland need not in any way imply that there was more money about: the opposite was probably true (Metcalf 1977:11).

It is possible that the cessation of hoarding is purely a function of more peaceful times, brought on perhaps by the centralization of power by strong earls such as Þorfinnr Sigurðarson (d. c.1065) who is said to have ruled nine earldoms of Scotland as well as the Hebrides, Orkney and Caithness (Crawford 1987:133-134; Pálsson & Edwards 1981:75). This process may, however, be more complicated than an outbreak of relative peace. The reduction in the number of hoards could also relate to a parallel reduction in the number of individuals or groups with the power to amass substantial fluid wealth. If relative stability was achieved, it may have been at a cost to previously independent magnates capable of large scale trade or of paying their own retinues. This process cannot, however, have been entirely successful. Semi-independent magnates such as Sveinn Ásleifarson play a substantial role in the 12th century events for which *Orkneyinga Saga* is most reliable (see Section 4.3).

This model is attractive if we accept that hoards served exclusively as "banks" in the Late Norse Period. Support for this assumption comes from sources such as *Njal's Saga*, where some vikings had "a hoard of treasure hidden ashore" (Magnusson & Pálsson 1960:89; see also Crawford 1987:128). It is suggestive, however, that the decline in hoarding parallels (if possibly slightly later) the 10th-11th century adoption of Christianity - evidenced by both the decline in rich grave goods and historical sources (see Sections 4.3-4.4 above). Orkney was ostensibly (forcibly) converted by Óláfr Tryggvason in 995 but Earl Sigurðr Hloðvisson at least allegedly died under a magical raven banner in 1014 (Magnusson & Pálsson 1960:347-348; Pálsson & Edwards 1981:36-38). A more long-lasting transformation can probably be associated with his son Þorfinnr (d. c.1065) who established the earldoms' first bishop's seat at Birsay (Morris 1990:17-19; see Chapter 4). Was the failure to recover hoards sometimes intentional - associated in some way with ritual obligations or economic goals beyond our immediate perception? An anecdote from *Egil's Saga* - composed in the 13th century but allegedly referring to the 10th - provides an interesting lesson

(Pálsson & Edwards 1976:7). Dissatisfied with his heir, Egill secretly buried his chests of silver (which he had acquired as a mercenary in his youth) before dying (Pálsson & Edwards 1976:237). If grave goods - visibly buried with elaborate ritual - were for the living, perhaps hoards - hidden with stealth - were occasionally for the dead.

These two options by no means exclude other possible explanations for the failure to recover silver hoards. They do illustrate, however, that impoverishment is an unlikely alternative.

Having discussed the cessation of unrecovered hoards it is necessary to address their floret. Table 6.6, Based largely on Graham-Campbell's syntheses (1976:128-130; 1993:184), lists the relevant material from Orkney, Caithness and Shetland. It should be noted, however, that these hoards form one component of a distribution which includes the western seaboard of Scotland and outliers elsewhere in mainland Scotland (Graham-Campbell 1976:128-130; 1993:184).

The hoards include gold objects, silver coins (e.g. Arabic, Anglo-Saxon, continental, Norwegian), and large amounts of uncoined silver in the form of ingots, 'ring-money' (see Section 6.2), hacksilver (cut silver of diverse origins) and silver jewelry (Graham-Campbell 1976:119-124; Grieg 1940:119-142; Smart 1985:671). The ingots are similar in composition to others in Britain and X-ray fluorescence analysis suggests that they exhibit trends observable in Anglo-Saxon and perhaps Arabic coinage (Kruse & Tate 1992:323). While these results suggest that the Orcadian silver was ultimately imported, the ingots cannot be associated with a single identified metal source (Kruse & Tate 1992:317, 319, 323-324). It is interesting to note, however, the virtual absence of Hiberno-Norse coins from the hoards of Scandinavian Scotland (Smart 1985:69).

These hoards raise complex problems, some of which have been discussed above. The issues become somewhat clearer, however, if we separate the silver from its hoarded context. The act of burying silver, and then failing to (or choosing not to) recover it, is one which suggests a multiplicity of explanations, some prosaic, some deeply symbolic. One example along each avenue is suggested above. The silver objects themselves, however, reveal aspects of their role *before* burial. Three attributes are particularly pertinent to an interpretation of the nature of Viking Age and 11th century trade: the predominance of silver bullion and coin over finished jewelry, the presence of frequent nick marks and the possible existence of standard value units. All suggest a role as currency.

Unlike Pictish silver hoards, such as the St. Ninians Island and Broch of Burgar treasures, which exhibit finished objects of great aesthetic impact (Graham-Campbell

1985:250, 257; Small et al. 1973:46-80, 81-82, 89), much Viking and Late Norse silver displays a utilitarian character. Hoarded Pictish silver can easily be interpreted as prestige items appropriate for gift exchange or as *de facto* badges of office. Conversely, Viking ingots, hacksilver and ring-money are better interpreted as coinage without a king. In the absence of a single power to control and enforce the use of a standard coinage, silver bullion would provide a convenient currency for 'cross-border' trade (see Kruse 1988:285 and references therein). The absence of native coinage need not imply the absence of a market economy as Kruse (1993:196-200) suggests - it simply implies the possible absence of a royal power with a monopoly on the control of exchange.

The utilitarian character of this silver is emphasised by frequent "nicking" marks, interpreted as purity checks (see Archibald 1990:11). Kruse's study of Scottish (including Orcadian) Viking Age ingots is particularly revealing. Of the surviving ingots examined (all except one), 48% exhibited 1 to 4 nicks, 26% 5 to 9 nicks and 23% more than 10 nicks (Kruse 1993:189). Kruse (1993:189) draws particular attention to one ingot from the Skaill hoard which exhibited 30 nicks. These nicks not only suggest that silver was frequently exchanged, but also that the receiver was sufficiently concerned about its future exchange value, possibly his or her profit, to check its purity. It could be argued that nicked silver was simply imported by the plunder of foreign merchants (see Kruse 1993:189). This is unlikely, however, given the presence of ingot moulds in both Viking Age and LN1 contexts in the earldoms (Batey & Freeman 1986:292; Curle 1982:81, 84; Hamilton 1956:134). The inhabitants of Shetland and Orkney were fully engaged in whatever economic process nicked ingots imply.

Analyses of the weight of hoarded silver objects is similarly suggestive. Although Kruse (1988:293, 295-296; 1993:193-196) suggests that earlier studies (see Wallace 1987:206; Warner 1976) have probably attempted to be overly precise, she has found that the weight distribution of Scottish ring-money is bimodal with peaks in the low 20g range and also around 50g. Scottish ingots exhibit no such clustering despite visible patterns in their English analogs (Kruse 1988:293-295; 1993:193). There is no clear explanation for this, but Kruse's (1993:196) comment that "hacksilver would always have been on hand to top up the scale pan" is probably apropos. The study of Viking Age weights - usually lead bases with bronze caps - is complicated by their susceptibility to corrosion (Kruse 1988:287; 1993:195). Nevertheless, the very existence of weights and balances suggests the existence of quantitative standards. Weights and possible weights have been found in Viking Age and Late Norse levels at Sandwick (Bigelow 1984:245, 268), the Beachview Studio Site (Batey et al. forthcoming d), The Brough of Birsay (Curle 1982:79; Hunter & Morris 1981:253)

Brough Road Areas 1 and 2 (Batey 1989a:194) and Buckquoy (Ritchie 1976-1977:189, 199; see also Dalland 1992:475). Balances have been perceived as more common finds in the Western Isles than in the earldoms proper (Ritchie 1993:85). However, a fragmentary balance beam was recovered from a Late Norse context at Jarlshof (Hamilton 1956:174) and a folding bronze balance, possibly from a disturbed Viking grave, was found in superficial layers at the Brough of Gurness (Hedges 1987:73, 87).

The origin and use of hoarded Norse silver has been interpreted in a variety of ways. Kruse (1993:196; see also Graham-Campbell 1993:180) provides a useful summary: plunder (or military pay), tribute, gift-exchange and trade. Moreover, she adds the possibility that silver was used primarily as a status indicator (Kruse 1993:199-200). As discussed above, these economic processes are not necessarily mutually exclusive. A degree of plunder is to be expected (see Section 6.2). Complete objects, such as the almost unwearable silver ball-type penannular brooches of the Skaill hoard and the gold rings of the Stennes hoard, can easily be interpreted as prestige goods for gift exchange or "tournaments of value" (Appadurai 1986:21; Graham-Campbell 1993:182; see Grieg 1940:Figure 60). Conversely, hacksilver and nicked ingots seem eminently unsuitable media for such exchanges. One could argue that they served a role in trade, or conceivably as tribute and military pay which could subsequently be used in market transactions. Ring-money lies between these extremes. Crawford's (1987:134) suggestion that it served both for trade and the payment of tax is difficult to prove but not unreasonable.

The fourth category of imported Late Norse 'currency' - single finds of coins, ring-money, rings and gold or silver fragments dating to the Viking Age and the VA/LN transition - can be interpreted in similar ways. The published finds, based primarily on Graham-Campbell (1976:131; 1993:184) and Stevenson (1986:340-341) are listed in Table 6.7. The single 9th century example, a coin of Burgred (d. 868), is pierced as an ornament (Batey & Morris 1983:93-94; Stevenson 1986:340). However, Stevenson (1986:339) has suggested that the 10th and 11th century coins exhibit "a potentially monetary or exchange function". It may be possible to extend this suggestion to include finds of ring-money or hacksilver at Jarlshof (Hamilton 1956:152), the Brough of Birsay (Hunter 1986:187) and the Beachview Studio Site (Batey et al. forthcoming b). Other objects, such as rings and fragments of silver or gold, are more difficult to interpret (Table 6.7). Some may relate more closely to non-market exchanges.

Kruse (1993:198) is rather dismissive regarding this assemblage, citing the small number of items and the unrepresentative character of the sample (4 of 11 coins are from the high status Brough of Birsay). It is interesting, however, that there are *any* stray finds of silver coins, ring-money and hacksilver from settlement sites. While one of the 17 probable currency items (by which I mean unpierced coins, ring-money and hacksilver) in Table 6.7 derives from a burial, the number found in less symbolic contexts suggest casual treatment and/or frequent transactions . If complete silver objects, gold rings and gold fragments are included as potential currency, the total number of single finds from the Viking Age and Late Norse Period is twenty-eight (excluding the three 12th-14th century coins discussed above). Eight pieces are from Shetland, eighteen were found in Orkney and two are from Freswick Links in Caithness.

Taken together, the archaeological evidence for Late Norse trade is modest in scale. Pottery provides a useful example. The published count of imported sherds from both divisions of the Late Norse Period is c.482 (or 128 excluding the Kirkwall assemblage). This observation must, however, be qualified in two ways. The first is a matter of comparison; the earldoms were largely rural in character, particularly prior to the 12th century (see Section 6.8.3 below). The quantity of imported finds should not, therefore, be assessed in comparison with the rich artifactual assemblages of urban sites such as Aberdeen, Bergen, Dublin and Trondheim (e.g. Blackmore & Vince 1994; Murray 1982; Reed 1990; Wallace 1987). This is of particular relevance to Graham-Campbell (1976:127) and Kruse's (1993:199) interpretation of the Viking Age and Late Norse silver evidence. By comparing Scottish hoards to the much larger Irish corpus (see Kenny 1987) both conclude that overseas trade and silver-circulation were limited in Scotland (Graham-Campbell 1976:126-127; Kruse 1993:197). This conclusion is reasonable and, as Graham-Campbell (1976:127) suggests, not particularly surprising given the urban character of Scandinavian settlement in Ireland. However, it is not the only possible comparison. The earldoms of the 10th and 11th centuries were anomalously silver rich in relation to the emerging Scottish kingdom (Smart 1985:66-67). It is worth noting in this context that the Burray hoard, from the Orkney island of the same name, is the second heaviest known from Scotland (Graham-Campbell 1976:123) and that the Skaill hoard is

> similar in size to the largest known Viking-Age hoards that have been found in Scandinavia. At the same time, however, it is three times larger than any of the equivalent 10th century hoards from Norway, and four times heavier than any other Viking Age treasure from Scotland (Graham-Campbell 1993:180).

Moreover, even a modest volume of trade could be remarkable important to a relatively diffuse rural population. The reliance of Iceland on imported grain and timber during and after the Commonwealth period provides an illuminating analogy (e.g. Gelsinger 1981:14-16, 155-156). Despite an ample historical record of trade only

6 sherds of mediéval imported pottery predating the 15th century have yet been found in Iceland (Sveinbjarnardóttir 1992b:155-157).

Second, it is probably unwise to interpret the most recognisable archaeological imports, such as pottery and steatite, as the only objects of trade. Post-medieval historical evidence indicates that archaeologically ephemeral goods such as fishing lines, nets, brandy, mead, beer, wheat- and rye-meal, fruit, salt, tobacco, textiles, household furniture and currency were major imports to Shetland and Orkney (Brand 1883[1701]:199-200; Fenton 1978:3; Friedland 1983:92; Shaw 1980:176, 179; Smith 1984:18, 28). It could be argued that trade for some of these products was unlikely to constitute an increase in wealth. However, they include both vital means of production (e.g. fishing lines, salt, currency) and prestige goods for the expression of hierarchical socio-economic relationships (currency, exotic foods, beverages, clothes and furnishings). This last issue will be addressed in greater depth in Chapter 9.

Given the virtual absence of waterlogged archaeological deposits in the earldoms (see Crone n.d.; Dickson n.d., Owen 1993:330 and McCullagh 1982 for exceptions) the apparent paucity of organic products is not surprising. The circumstances of preservation are fundamentally different from those at urban sites such as Anglo-Scandinavian York where imported goods such as silk have been recovered (e.g. Muthesius 1982:132-136). Nevertheless, it is worth mentioning the few carbonised grains of wheat recovered at Freswick (Huntley & Turner forthcoming), Robert's Haven (Huntley pers comm.) and Earl's Bu (Huntley 1990). It is possible that these were not grown locally given the complete dominance of barley and oats in Viking Age and Late Norse botanical assemblages (see Section 5.4 above). While currency is not subject to preservation problems, careful curation may be partially responsible for its relative scarcity subsequent to the 11th century decline in unrecovered hoards.

6.8.3 Markets

Evidence for the existence of markets in the earldoms pertains largely to the Late Norse Period. It takes two forms. The first is evidence for the existence of trading towns with some formal status. There is good evidence for the existence of such a settlement at Kirkwall, Orkney, at some point in the 12th century (McGavin 1982:392). Less convincing is the possibility that similar, if less substantial, trading centres existed at Thurso and/or Wick in Caithness. The second is evidence for *ad hoc* trading in bays and harbours which was nevertheless under some political control.

Trading towns are unlikely to be of great significance in Orkney and Caithness until the 11th or 12th centuries. The first justification for this statement is the fact that the larger polities to which the earldoms were at least nominally subject did not exhibit fully urban characteristics until this time. The trading towns of Scotland, the burghs, were established and controlled under the direct authority of King David I (reign 1124-1153) and his successors (Barrow 1981:84-104, 180; Smart 1985:66). Norwegian urbanisation preceded this development, but only by c.100 years. Saga tradition ascribes the foundation of Nidaros (Trondheim) to Óláfr Tryggvason (reign 995-1000) and the foundation of Oslo, Bergen and Konungahella to succeeding 11th century kings (Gelsinger 1981:63-64; Long 1975:5). Archaeological evidence dates the development of towns such as Trondheim, Oslo and Bergen to the 11th century (Herteig 1985:26-27; Long 1975:11, 27; Schia 1987:497). Although Ohthere's Sciringes heal (Fell 1984:21-22), equated with the archaeological site of Kaupang, Vestfold (Blindheim 1975:125-128; 144; Blindheim 1982:10), flourished in the 9th century, it is evident that it was followed only slowly by formal urban organisation elsewhere in Norway (Clarke & Ambrosiani 1991:68).

In *Ancient Immigrants* A.W. Brøgger (1929:121) suggested that the Viking Age cemetery at Pierowall, Westray, Orkney, provided evidence for a trading centre which he equated with the place-name Hofn of *Orkneyinga Saga*. As Small (1968:15; 1971:86) and Morris (1985:233) have observed, however, there is little evidence to sustain the assumption. First, the saga reference is to the 12th century and explicitly mentions a farmer at Hofn (Pálsson & Edwards 1981:133). Moreover, the substantial assemblage of grave goods (which has been masterfully reconstructed from early excavation records by Thorsteinsson 1968:164-172) lacks the balances and weights typically associated with merchant activity (e.g. Blindheim 1975:135; Ritchie 1993:83). It includes, instead, symbols with military and agricultural associations such as weapons and sickles (Thorsteinsson 1968:164-172). The minimum of 17 graves from Pierowall may hint at a relatively dense population - one characteristic of urbanism. It compares rather palely, however, to the "hundreds" of burial mounds near the small Viking Age trading centre of Kaupang, Vestfold (Blindheim 1975:132).

Kirkwall, the most likely candidate for a permanent marketplace in the earldoms, received little mention in the saga literature until events of the 12th century. The *Short Magnus Saga* (Dasent 1894a:283-301) contains the following account referring to events which may have taken place in 1135 (not 1117 as suggested by McGavin 1982:392, see Thomson 1987:61-62):

> Bishop William fared east [from Birsay] to Kirkwall with a worthy company and brought thither the halidom of earl Magnus. The shrine was set over the altar in the church that is there. The market town of Kirkwall had then few houses, but it has since spread out much (Dasent 1894a:296).

The relocation of the Episcopal seat and the relics of St. Magnus from Birsay, and the foundation of St. Magnus Cathedral under direct patronage of Earl Rǫgnvaldr, must have provided the impetus for stability and growth (Dasent 1894a:294; Pálsson & Edwards 1981:130-142; see McGavin 1982:392; Morris 1985:233).

The town may have functioned as a focus of settlement and trade before this date. It is mentioned, for example, as a residence of Earl Rǫgnvaldr Brúsason (d. 1045?) (Pálsson & Edwards 1981:70; see Lamb 1993a:44). Moreover, the Romanesque door of a possibly early 12th century church dedicated to St. Ólafr survives in Kirkwall (Lamb 1993a:46; RCAMS 1946a:141-142). Nevertheless, Lamb's (1993a:44-45) suggestion that Kirkwall functioned as a merchant centre as early as the mid 11th century is difficult to demonstrate with confidence. Rǫgnvaldr Brúsason's residence need not have attracted merchants more than other populous estates. It seems probable that the Late Norse earls maintained a peripatetic lifestyle - moving among their farms and the farms of their followers. For example, 11th, 12th and 13th century earls resided in Birsay, Kirkwall, Orphir, Westness, Wick, Thurso, Murkle and probably Halkirk (Crawford 1982:64, 72; Dasent 1894a:232; Dasent 1894b:155; Pálsson & Edwards 1981: 70, 75, 120, 124, 185, 195). It is more reasonable to suggest that *early 12th century* developments in Kirkwall must have preceded the transfer of St. Magnus' relics from Birsay (Lamb 1993:45).

The best historical evidence for Kirkwall's role as a trading town following the 12th century actually post-dates the Late Norse Period proper. After the pawning of Orkney to Scotland in 1468, King James III saw fit to officially acknowledge the towns role as a trading centre. It was erected a Royal Burgh of Scotland in 1486 (Convention of Royal Burghs 1878:611; Thomson 1987:114-115). The central role of Kirkwall in the earldoms from the late 12th to 15th centuries cannot be disputed. It served as the main (although not the only) seat of earls (Clouston 1914:27; Thomson 1987:96-97; see above), bishops (Clouston 1914:15-18, 33; Dasent 1894b:365) and the king of Norway's stewards (Clouston 1914:4, 10-11, 15-18; Donaldson 1974:36). Moreover, it was in Kirkwall that King Hákon Hákonarson of Norway spent his last winter in 1263 (Dasent 1894b:365-369). It is also suggestive that payments agreed in the Treaty of Perth (1266) between Alexander III of Scotland and Magnús Hákonarson of Norway were to be paid in Kirkwall (Donaldson 1974:36).

Archaeological evidence for Kirkwall's role as the primary political, ecclesiastical and probably economic focus of the Late Norse earldoms takes three forms. The first is the surviving monumental architecture of St. Magnus Cathedral and the Bishops Palace, substantial portions of which date to the 12th and 13th centuries (Cruden 1988:83-84; Fawcett 1988; Gifford 1992:327; Simpson 1961:72). Second, McGavin's (1982:401-

402) excavations beneath Tankerness House, Kirkwall, have revealed a possible jetty pre-dating rubbish deposits which include Scottish and English pottery of 13th to early 14th century date. Another possible wharf, pre-dating the 16th century, was located during archaeological monitoring of road works in 1986 (Lamb 1993a:47). The third is evidence for the expansion of the settled area from the 13th-14th through 19th centuries (Lamb 1993a:45-48; McGavin 1982:430-431). This is shown in sharp relief by the gradual infilling of the Peerie Sea to support the expanding town. At the 57 Albert Street Site, c.33m of shore had been reclaimed by the 15th-16th centuries (McGavin 1982:430-431).

The evidence to suggest that Thurso may have been a trading centre for Caithness is tantalizing but slim. Thorson (1968) suggested that it may have served as a religious and judicial centre in the Viking Age based on place name evidence. The reliability of his conclusion has, however, been challenged (Nicolaisen 1982:84-85). *Orkneyinga Saga* (Pálsson & Edwards 1981:194) and *Hákon's Saga* (Dasent 1894:155) do imply a focus of population at Thurso. For example, Sturla Þórðarsson (writing c.1265, see Cowan 1990) suggested that in the winter of 1230-31 Thurso held sufficient lodgings for Earl Jón Haraldsson and Hanef, the King of Norway's Steward, both of whom "had a great train of followers" (Dasent 1894b:x, xxvi, 155). It is also suggestive that the settlement often served as a central place for communication between Orkney and Caithness (e.g. Pálsson & Edwards 1981:137, 183, 214, 222). A castle at Thurso is associated with the earls Haraldr Maddaðarson and Rǫgnvaldr Kali Kolsson (Pálsson & Edwards 1981:193). Moreover, it has been argued that St. Peter's Kirk, parts of which may date to the early 12th century, served as the Bishop of Orkney's Minster in Caithness or conceivably as the earliest seat of the bishopric of Caithness (after its creation in the mid-12th century) (Crawford 1993:131; Slade & Watson 1989: 299-301, 307-309). A stronghold of the Bishop of Caithness, at Scrabster near Thurso, is mentioned in *Orkneyinga Saga* (Pálsson & Edwards 1981:222) and in the *Exchequer Rolls of Scotland* under the year 1328 (Stuart & Burnett 1878:116). The ruins have been excavated by Talbot (1970; 1973a; 1973b).

Although Thurso has several of the key characteristics of a medieval town - a relatively large population, a role as a central place, evidence of central authority, defenses, 'monumental' architecture and religious organisation (see Hodges 1989a:21-22) - there is no direct evidence for a market function in the Late Norse Period. Thurso was a substantial trading settlement in the 18th century, but did not receive official burgh status until 1633 (Miller 1989a:98-99; Mitchell 1906:169; Omand 1989:132). It is possible that the potential of Thurso as an administrative and economic centre was defused when the diocesan seat was moved, if it ever did reside in Thurso, first to Halkirk up the Thurso River valley and ultimately (c.1224) to Dornoch in the newly (or soon to be) erected Scottish earldom of Sutherland (Crawford 1985b:27, 33; Slade & Watson 1989:300-301).

Wick is also specifically mentioned in *Orkneyinga Saga*, both incidentally and as a residence of Earl Haraldr Maddaðarson (Pálsson & Edwards 1981:147, 151, 185). It seems reasonable that the latter reference can be associated with the potentially 12th century castle of Old Wick (Gifford 1992:113; Talbot 1974:40). There is nothing to suggest, however, that Wick differs from other royal or aristocratic estates, some also associated with castles. The surviving castle on the Island of Wyre, Orkney, provides a good example (RCAMS 1946a:235-239). It can be associated with a 12th century magnate, Kolbeinn Hrúga, mentioned in both *Orkneyinga Saga* and *Hákon's Saga*, (Dasent 1894b:156; Pálsson & Edwards 1981:155). Wick was recorded as a burgh of barony in the 1390s (Pryde 1965:47). Nevertheless, the town did not receive a royal charter until 1589 (Calder 1887:344-346; Pryde 1965:28) and the Sheriff of *Inverness* had responsibility for at least some aspects of local justice in late 13th century Caithness (MacQueen 1990:88).

In balance, it would seem that Kirkwall, and possibly Thurso, functioned as market towns during portions of the Late Norse Period. Before and concurrent with these developments, however, we must look for mechanisms of market exchange outside a formal marketplace (see Hodges 1989a:15 for a discussion of the distinction between the market principal and the market place). One account from *Orkneyinga Saga*, allegedly referring to the middle years of the 1130s, is particularly revealing: The magnate Sveinn Ásleifarson exchanged his ship for a cargo boat (significantly at Thurso) and traveled through Eynhallow Sound towards Rousay where Earl Páll was feasting with his supporter, Sigurðr of Westness. The earl's men spotted the cargo boat from a headland and "shouted for them to row on to Westness and give Earl Paul whatever they had on board, thinking that they were talking to some merchants" (Pálsson & Edwards 1981:137-138). It is possible to envision merchants seeking out earls, or simply the settlements of well known magnates. This arrangement would ensure a local monopoly on the use of violence (a logical prerequisite for peaceful trade [Skovgaard-Petersen 1981:12-13]), and trading partners with access to substantial wealth in commodities or currency. It is also possible that the landing points served as local markets for all segments of society, presumably with some benefit pertaining to the host. This pattern is observable in saga descriptions of contemporary Iceland, a polity similarly lacking in urban settlements (Byock 1993:87-90). The 13th century *Njal's Saga* provides a useful example. Hallr of Sida invites Thangbrand to stay at his house and offers to "take the responsibility for marketing your [Thangbrand's] goods" (Magnusson & Pálsson 1960:218). Similarly, in *Eyrbyggja Saga*:

> In the summer that Christianity was adopted by law in Iceland a ship from Dublin put in at Snæfell Ness. Most of the crew came from Ireland and the Hebrides, but there were some Norwegians too. They lay at Rif for a good part of the summer, then with a fair wind sailed up the fjord to Dogurdar Ness, where a number of people from the neighbourhood came to trade with them (Pálsson & Edwards 1989:129).

Another model of trade outwith the permanent marketplace is suggested by the 17th century pattern in Shetland. Hanseatic merchants occupied specific bays and exchanged their goods directly with the producers of the commodities they sought, principally dried fish. Trade was conducted with peasants, with a church minister (in 1649) and with fishermen (Friedland 1983:92; 1973). The local representative of political authority, the foud, derived wealth from this trade by levying duty on imports and exports, dues for the use of bays, dues for the right to build booths on land and special gifts such as decorated rifles (Friedland 1973). A similar model can probably be recognised in medieval Arctic Norway where King Óláfr V (d.1387) tried to forbid "trading in Fjords and fishing stations" (Urbanczyk 1992:145). In this model, those with political authority were able to acquire wealth from merchants simply by facilitating trade in *ad hoc* market places.

Further models of market trade without towns are of course possible. Temporary fairs were a common feature of medieval and post-medieval Europe, including Scandinavia and Scotland (Low 1879[1774]:63; Hodges 1988:43-46; Pounds 1994:357-364; Sawyer 1986; Withrington & Grant 1979[1791-1799]:28, 266). The ethnographic literature is also rich in examples of trade outwith permanent marketplaces (see Hodges 1988). Regardless of the precise mechanisms involved, it is clear that export trade could have predated the development of towns such as Kirkwall, and could have functioned in areas such as Caithness or Shetland which lacked well developed market places.

6.8.4 The Products of Export

If external trade played a role in the Viking Age and Late Norse economy, as the evidence just reviewed suggests, what were the products of export? What elements of primary wealth (discussed in Chapter 5) could be converted into more valuable products - either directly through trade or indirectly by taxing trade. To begin, it is illuminating to look at post-medieval export records. Based on 17th century accounts, Shaw (1980:165) compiles the following list for Orkney:

> the victual [primarily malt and barley] and butter in which rent payments were for the most part made; other animal products such as hides, skins, meat and

tallow; wool, woolen cloth [also known as wadmel] and stockings; fish, feathers, and salt from the salt pans of the calf of Eday.

A similar list could be compiled for Shetland and Caithness, with the addition of oil, (predominately from fish, but also from sea mammals and birds, see Baldwin 1974:97 and Fenton 1978:525-527, 530-531, 545, 548, 598) and furs (Goudie 1904:165-193; McNeill 1901:325-327; Mitchell 1906:169; 1908:86; Shaw 1980:173-177; Smith 1984:37). The *quantitative emphasis* among these products varied in each region. For example, the Shetland export trade was more heavily dominated by fish (Shaw 1980:174) while Caithness and Orkney exported substantial quantities of grain (Mitchell 1906:169; Shaw 1980:166-167). The actual *products* of trade, however, were similar throughout the area which had comprised the Late Norse earldoms.

Using the post-mediaeval evidence as a starting point, it is possible to suggest which of these products were likely candidates for export in earlier centuries.

Evidence for the export of cereal products is the most conclusive. The widespread cultivation of barley and oats in Viking Age and Late Norse Orkney, Caithness and parts of Shetland has been established in Section 5.4. Moreover, direct historical evidence for the export of grain exists for the Late Norse Period. Two 13th century saga accounts which refer to the shipment of malt and grain from Orkney to Iceland have been mentioned in Section 6.8.2 above (McGrew 1970:129-130; Porter 1994:110). The early 15th century "Complaint of the people of Orkney about the misrule of David Menzies of Weem" records the export of corn to Scotland by the foud (royal administrator) of Orkney (Clouston 1914:37). It is also conceivable that King Sverrir's speech of 1186 -in which he thanked Orcadians, Shetlanders and others for "such things as make this land [Norway] the richer, and we cannot do without" (Sephton 1899:129) - referred in part to grain (Thomson 1987:110).

Despite the obvious importance of pastoralism in the earldoms (see Section 5.5 above) trade in butter is less easy to substantiate in the Late Norse Period. The scale of this trade in Norway is suggested by King Hákon V's ban of 1316 on the removal of butter from the country unless exchanged for grain products (Urbanczyk 1992:141). It is also suggestive that many Norwegian rents and other tributary dues were payable in butter during the 14th century (Urbanczyk 1992:154, 236).

The best evidence for the participation of the earldoms in this trade is indirect. The earliest surviving records of rent, tax and tithe for Orkney, Shetland and Caithness make explicit reference to butter. While some quantity must have served subsistence needs - particularly the maintenance of retinues by feasting - analogies from later centuries suggest that the products of rent were often destined for export (Shaw 1980:165-166, 173). An addition to the *Orkneyinga Saga*, referring to 1222 A.D., records a dispute between Bishop Adam of Caithness and his flock regarding an increase in the butter tax or tithe (Crawford 1985b:28; Dasent 1894a:232). Records of secular payments in butter are much later in date, but derive from the earliest surviving rentals of Orkney and Shetland. These include documents from the 15th and 16th centuries for Orkney and Shetland (Goudie 1904:171-177; McNeill 1901:325-327; Thomson 1987:119-120).

Wool products have been assumed, at least partially by analogy with Iceland and Faeroe, to represent Shetland's single most important export in the Late Norse Period (e.g. Gelsinger 1981:111-115). Like butter, however, evidence for the export of wool goods from the earldoms is indirect. Moreover, distinct regional differences are evident. The available late 15th and early 16th century rentals for Orkney and Caithness (Andersen 1989:21-22; Thomson 1987:119-122) do not include woolens. Conversely, wadmel (wool cloth) appears in contemporary documents relating to Shetland (McNeill 1901:325-327; Goudie 1904:173, 176; see Smith 1984:37 and Section 5.5 above).

As discussed at length in Section 5.5 above, zooarchaeological evidence is more consistent with a pastoral system intended to provide both meat and secondary products than with an intensive dairy or wool economy. Although some cattle and sheep were killed as calves and kept into maturity - the assumed signatures of a focus on secondary products - many were also killed at intermediate ages. This pattern holds for both the Viking Age and Late Norse Period with little evidence of temporal change. Although a multi-purpose pastoral strategy is not entirely inconsistent with the export of milk or wool it does not strengthen the case for such a trade. Given the indirect character of the historical evidence the export of butter and wadmel must remain a probability rather than an established 'fact'.

The export of hides, skins, meat and tallow are similarly difficult to substantiate with direct evidence. Viking Age or Late Norse trade of specific animal products is completely unknown to the author. There is some indirect evidence, however, which suggests that whole animals may have been exported by land or sea. Chief amongst this evidence is the account of Alexander III's fine on the people of Caithness in 1264 (in retaliation for their enforced support of Hákon Hákonarson's campaign in Scotland) (Crawford 1985b:38). Combining the evidence from several sources, Crawford pieces together a series of events which includes the forceful collection of 200 cows, their drive south and the successful interception of the Scottish force by Lord Dougal of the Isles who "seized the great sum which they were carrying off"

(Crawford 1985b:38). Moreover, Crawford (1985b:32, 41) suggests that this, or another, fine of cattle became a permanent imposition on the people of Caithness in the late 13th century. It is possible, if far from conclusive, that this fine followed an established trade akin to cattle droving from the highlands described in 17th and 18th century sources (Baldwin 1986:200-201; Withrington & Grant 1979[1791-1799]:259). The fact that the Bishop of Caithness took his tithe of King Alexander's fine may provide slight support for the suggestion that the movement of cattle was already an established institution in 1264 (Crawford 1985b:38).

The evidence in favour of feather export in the Late Norse Period or Viking Age is somewhat fragile. Necessary preconditions are met - wild birds were abundant (if possibly legally regulated) in the earldoms, probably in large nesting colonies as they are today (Baldwin 1974:90-95; Berry 1985:141; Berry & Johnston 1980:170, 182, 189, 206, 208-209, 215; Kaland 1982:89-91; See Figure 2.8). Moreover, bones of birds (particularly seabirds) are present in all Viking Age and Late Norse faunal assemblages for which detailed identification of bird bones has been attempted (Table 5.7). Feathers were desired products in 13th century Iceland (e.g. Pálsson & Edwards 1989:133) and served as rent in the Scottish Isles in later centuries (Fenton 1986a:124). However, there is no direct evidence for their export in the Viking Age or Late Norse Period. Moreover, the number of bird bones recovered archaeologically is relatively tiny.

I am unaware of any evidence for the export of salt or furs from the earldoms in the Viking Age or the Late Norse Period. The export of salt seems unlikely, given the record of its import in both the 14th century (Burnett 1878:308) and the post-medieval period (Friedland 1983:93). Furs were certainly an important item of Scandinavian trade as early as the Viking Age (Fell 1984:20; Sawyer & Sawyer 1993:145). It is salutary that this trade, which had been considered archaeological invisible (Hodges 1989a:105), has recently been identified at Viking Birka by the presence of distal limb bones from fur bearing animals (Wigh 1994). Rabbits, whose skins were exported from Orkney in the 16th century (e.g. McNeill 1901:326), are not uncommon in the faunal assemblages summarised in Table 5.5 (see also Guðmundsson 1965:264 regarding hunting 'hares', *hera*, in Orkney). Diagnostic skinning patterns like those at Birka have not been recognized, however, and many of these bones are likely intrusive products of burrowing (see Rackham 1989:MF4G6 and Section 5.8 below).

Several products which had fallen out of fashion by the post-medieval period also deserve attention. It is possible, for example, that phyllite hone stones and steatite vessels from Shetland were traded over considerable distances. A hone which may derive from Shetland phyllite found at the Beachview Studio Site has been mentioned above (Bátey et al. forthcoming d). Moreover, steatite vessel fragments discovered in Anglo-Scandinavian deposits at York have been attributed a possible Shetlandic origin on the basis of thin section examination (MacGregor 1982:74). As Ritchie (1984:78) observes, however, visual similarity does not *prove* a common origin.

Some attention has been paid to the potential role of slave trading among the Viking Age colonies of the British Isles (e.g. Crawford 1987:210; Smyth 1977:154-168; Wilson 1976:110). The importance of this trade in eastern Scandinavia is well documented (Sawyer 1982:114-116) and 8th-9th century records of raids on 'Scottish' centres such as Iona and Dumbarton imply that slaves were economically important in the west (e.g. Anderson 1990[1922]:256, 258, 302-303). An entry for 871 from the *Annals of Ulster* is particularly suggestive:

> Olaf and Ivar came again to Dublin from Scotland, with two hundred ships; and a very great spoil of people - of English and Britons and Picts - was brought with them to Ireland in captivity (Anderson 1990[1922]:302-303).

Citing this and further evidence, Smyth (1977:154-168) has gone so far as to suggest that Dublin was the centre of a substantial slave trade.

The importance of slaves in the 10th and later centuries is more difficult to interpret. Nevertheless, it seems likely that the scale of slave raiding significantly declined following the consolidation of the northern earldoms and the Scandinavian kingdoms of Man and the Hebrides (see Chapter 4). The supply of appropriate victims would be exhausted or integrated into a syncretic society. Moreover, in other regions of the Scandinavian world slavery dissolved as a social category in the late 12th century as "taxation forced peasant proprietors into tenancy" and landless people had to join the households of others to survive (Karras 1988:145, 160-163; see also Durrenberger 1988:119). Surviving Norwegian law codes of the 12th and 13th centuries do include provisions regarding slaves, but Larson (1935:13, 26-27) suggests that these were perceived as obsolete by the latter century.

In summation, the evidence discussed in this section suggests that the export of cereal (particularly from Orkney and Caithness) and possibly pastoral products may have been of considerable economic importance in the Late Norse earldoms. Direct evidence is available regarding cereal products, and suggestive indirect evidence exists for butter, wadmel and possibly cattle. Agricultural products may also have been important items of trade in the Viking Age, but this can only be suggested by extrapolating the Late Norse evidence back in time. Other possible exports - such as furs, feathers, stone products and slaves - were probably always of minor significance (at least after the violent conquests of VA1).

6.9 A Fish Trade

6.9.1 Introduction

Although agricultural products were exported from the earldoms, there are reasons to believe that they may not reveal the entire story of Late Norse export trade. First, cereal products (the most firmly established Late Norse export) were not always in abundant supply. The export of grain from Orkney shortly before 1424 left the population suffering a shortage by which a commentator suggested "the country was almost ruined" (Clouston 1914:37). Shortages are noted more frequently in later sources, with starvation or riots occasionally the result (e.g. Withrington & Grant 1978[1791-1799]:124, 143, 146-147; Brand 1883[1701]:39-40; Fenton 1978:332-336; Martin 1981[1716]:372; Miller 1989b:111; Pope 1979[1774]:328; Sibbald 1845[1711]:12). While this may be partly attributed to the climatic deterioration of the Little Ice Age (see Section 2.6), weather events probably had sporadically extreme effects on Late Norse and Viking Age agriculture. Barry (in Withrington & Grant 1978[1791-1799]:146-147) provides a vivid description of some potential problems:

> Very unlike the more favoured regions in the south, where the spring comes in early with a genial warmth, our spring continues cold until the month of June and July, when the vegetation is very rapid, and both corn and grass flourish much, till they are checked in the month of August, which too often blasts the hopes of the husbandman. About that season the winds generally blow with such fury from the west and south-west that the sea by dashing against the rocks, which on that side of the country are high, steep, and rugged, spreads a shower or spray of salt water over almost the whole islands. By means of this spray, the grass which before looked green and healthy, and the fields of corn which had promised plenty for man and beast, in the space of one night put on the garb of mourning, looking black as if they had been burnt, and are henceforth almost good for nothing.

Pre-improvement records of cereal export *are* common (see Section 6.8), but often carry important caveats such as "in years of fruitfulness" (Withrington & Grant 1978[1791-1799]:120), "in tolerable years" (Withrington & Grant 1979[1791-1799]:250) and "in fruitful seasons" (Pope 1979[1774]:328; see also Withrington & Grant 1978[1791-1799]:10). Moreover, the potential for cereal cultivation varied considerably from island to island (e.g. Low 1879[1774]:49). Butter, wadmel and other products would be less susceptible to short term or local agricultural limitations, but are unlikely to constitute the only commodities of export. As mentioned above, post-medieval sources record the substantial role of fish products as an article of commerce in Orkney, Caithness and Shetland.

The availability and utilization of fish, particularly of the cod family, Gadidae, in Viking and Late Norse Orkney, Caithness and Shetland is indisputable. The potential dietary importance of this resource is amply illustrated by the archaeological evidence discussed in Section 5.6 above. The local consumption of fish is evident from domestic middens where their bones are found amongst other household food refuse. It is tempting to suggest, however, that some of the fish caught in at least the Late Norse Period was destined for export. Although not conclusive, suggestive bodies of historical and archaeological evidence are worth further investigation. The historical evidence takes three forms: analogies from better documented areas of the northern medieval world, direct historical records which may imply fish trade from the earldoms and analogies from better documented periods in Orkney, Caithness and Shetland. The archaeological evidence, on which Chapters 7 and 8 will focus, includes substantial Late Norse fish middens discovered in the earldoms over the past two decades.

6.9.2 Norwegian, Icelandic and Scottish Historical Parallels

There is ample evidence for the involvement of the polities surrounding Orkney, Caithness and Shetland - Norway, Iceland and Scotland - in the export of cured cod family fishes between the 11th and 14th centuries. *Egil's Saga* (composed c.1230) includes an anecdote attributed to the 9th century in which fish was exported from Norway to England (Pálsson & Edwards 1976:49). The earliest evidence for a Norwegian export fishery in which any confidence can be rested, however, refers to the 11th century (Bertelsen 1985a:50; 1992:179; Urbanczyk 1992:132-133). By the early 12th century the evidence is quite strong. During the joint reign of the Kings Eysteinn, Sigurðr and Óláfr Magnússon, a royal decree required the payment of 5 fish per person fishing in Vågan, Lofoten (Urbanczyk 1992:133). At the same time, or slightly later, King Eysteinn ordered the building of houses and a church for fishermen in Vågan (Urbanczyk 1992:133). Archaeological evidence suggests that this Arctic fish entrepôt, Storvågan, may have been densely settled as early as the 10th century. It is not until the 13th century, however, that Bertelsen would interpret the evidence as urban in character (Bertelsen 1992:180; Bertelsen et al. 1987).

By the end of the 12th century, several sources mention the export of dried fish from Norway, primarily through Bergen (see Christensen 1985:255; Sephton 1899:129; Urbanczyk 1992:134). Hanseatic merchants conducted regular trade of Norwegian fish in the 13th century (Nedkvitne 1976:251-252; Urbanczyk 1992:137-8) and the oldest known Norwegian customs records, from 1316, include the export of cod, halibut and fish oil (Vollan 1959:343-344). Also in the 14th century, records from English ports such as Hull, Lynn, Newcastle and Scarborough mention the import of processed fish and fish oil from Norway (Bugge 1899:219-222; Nedkvitne 1976:250). Cod became the staple export of Norway in the 13th and 14th centuries, accounting for approximately 80% of the region's exports (Nedkvitne 1976:250; Urbanczyk 1992:230). While this trade was largely dominated by the German Hanseatic League by the end of the 14th century, Norwegian, English, Dutch and other merchants played an important role in earlier periods (Christensen 1985:255; Gade 1951; Ijzereef & Laarman 1986:437; Nedkvitne 1976; Urbanczyk 1992:137-138).

Iceland became involved in the export of cured fish by the late 13th century. In 1294 Icelanders attempted to prevent the export of their dried cod, but by 1340 dried fish and cod-liver oil were the principal products traded from the island (Gelsinger 1981:183-184). The earliest records of Scotland's involvement in the export of cured fish are of similar date. Great (i.e. royal) duties were not charged on the export of cod until the 15th century (Ditchburn 1990:83). However, cod did feature in the 13th century petty customs of Berwick (Stevenson 1988:186). Moreover, in 1281 Edward I of England commissioned a London alderman to buy 5000 salt fish from Aberdeen (Cutting 1955:35). It has also been suggested on faunal evidence that ling and halibut remains in 13th to 14th century levels of Lynn, England, may have been imported from northeast England or Scotland (Wheeler 1977:406). Although not of direct relevance to the cod trade, the export of salmon and herring from burghs such as Inverness and Aberdeen features in 13th and 14th century records (Cutting 1955:83; Ewan 1990:91; Stevenson 1988:186) The existence of other 13th century fishing settlements, such as Eyemouth near the English border, is confirmed by rental evidence (e.g. Dixon 1986:3). One argument in favour of a substantial 13th century Scottish trade in salt cod, the fact that it was known as "abberdaan" in Flanders (Stevenson 1988:186; see also Ditchburn 1990:85), is questionable. It has been suggested that the word is of Basque origin, having no association with Aberdeen (Cutting 1955:120; Vollan 1959:344).

6.9.3 Direct Historical Evidence

The small corpus of direct historical evidence for export trade from Orkney, Caithness and Shetland in the Late Norse Period has been discussed in Section 6.8 above. However, it is worth emphasising those records which may specifically imply fish trade. The earliest of these is an anecdote in *Orkneyinga Saga* (written c. 1200) allegedly referring to the 1120's. Kali Kolsson, later to be Earl Rǫgnvaldr of Orkney and Caithness, traveled with traders from Norway to Grimsby, England, where he met people from Orkney, Scotland and the Hebrides (Pálsson and Edwards 1981:109; Power 1990:21). It is tempting to interpret this gathering at a town later known for its fish market (Carus-Wilson 1933:173) as evidence for Orcadian involvement in the medieval fish trade. Two centuries later, in 1329, the royal treasury of Scotland paid for 15000 dried fish from Caithness (Stuart & Burnett 1878:239). An Exchequer Roll entry of 1368 may also provide a fleeting glimpse of fish curing. The Earl of Ross interfered with a shipment of one chalder* and eight barrels of salt, conceivably intended for salt fish production, en route to Orkney (Burnett 1878:308).

6.9.4 Later Trade in Orkney, Caithness and Shetland

Direct evidence for Late Norse fish trade from Orkney, Caithness and Shetland is thin. As mentioned above, however, there is ample evidence for the existence of such a trade from the 15th century and later. Regular Hanseatic trade with Shetland and Orkney, which was to have a great impact on the islands until the 18th century (Fenton 1978:3; Goodlad 1971:68-79; Smith 1984:10-20), is first recorded after 1415, when a Lübeck merchant Heinrich Sparke traded between Norway and Orkney and the Hansetag ineffectually decreed that voyages were forbidden to "Orkenen, Hydland [Shetland] unde to Ver [Faeroe]" (Friedland 1973). Fish products continued to play a major role in the economy of both archipelagos in later centuries (e.g. Brand 1883[1701]:30, 108, 110; Goudie 1904:165-193; Martin 1981[1716]:357, 368, 373, 385-386; McNeill 1901:325-327; Sibbald 1845[1711]:12). Although fishing was probably always more important in the less fertile Shetland islands, the contrast of the recent past between Orcadian 'farmers who fished' and Shetlandic 'fishers who farmed' was probably much less pronounced prior to the 18th century (Fenton 1978:8). At this time Orkney's merchant lairds directed the economy towards improved agriculture and large scale kelp collecting for English glass and soap manufacturers (Fenton 1978:575, 595; Thomson 1987:199-213). Conversely, Shetland's landowners intensified the fishing industry at the expense of agricultural improvement (Goodlad 1971:90-126).

Early post-medieval evidence regarding Caithness is limited. One document, relating to the years 1558-1559, describes the management of a salmon fishery in Strathnaver, Sutherland (Murray 1993). A 16th century document may also imply the existence of a salmon fishery at Wick in the 13th century (Crawford 1982:65-66; see Section 5.6). As discussed in Section 5.6, however, salmon are not evident in the Viking or Late Norse archaeological record. Wick is best known today for its role in the 19th century Scottish herring fishery, but this association is no older than the second quarter of the 18th century (Gray 1978:27-38; Sutherland 1985:35-36). Later records from Caithness do demonstrate the potential scale of cod exports. The customs book of Thurso for 1726 records the export of 40000 fish (Mitchell 1906:169; see also Brand 1883[1701]:232). It is the bones of this and related taxa that dominate Late Norse and Viking Age faunal assemblages.

* Approximately 3488 litres based on Barrow's [1981:173] conversion estimates.

6.9.5 Late Norse Fish Middens

Alone, this circumstantial historical evidence is not enough to support the argument that an export trade in cured fish made a substantial contribution to the wealth of Late Norse (or Viking Age) Orkney, Caithness and Shetland. Nevertheless, these limited data must be interpreted against the backdrop of a meager historical record regarding all facets of economy and society in the earldoms prior to the 16th century (see Section 3.2). Moreover, the possible existence of an export fish trade becomes difficult to ignore when confronted with the archaeological evidence of large Late Norse fish middens discovered over the last two decades in Orkney, Caithness and Shetland. The suggestion that bone deposits at sites such as Freswick (Batey 1989b:226), Quoygrew (Colley 1983a:208-217, 382-383), St. Boniface (Cerón-Carrasco 1994) and Sandwick (Bigelow 1984:128-129, 217; 1985:122; 1989:190) might derive from the preparation of fish for export is not new. As early as 1956 Hamilton argued that the Late Norse Period was characterised by an intensification in fishing activity (1956:6). More explicitly, Colley (1983a:382-383; 1983b:169; 1989:258-259), Batey (1989b:226), Bigelow (1984:128-129, 217; 1985:122; 1989:190) and Cerón-Carrasco (1994:208-210) have considered whether faunal evidence from several Late Norse sites could be indicative of a market oriented fishery. As discussed in Chapter 1, however, this research has proven inconclusive. Chapters 7 and 8 which follow present new results from investigations at Robert's Haven, Caithness, and Earl's Bu, Orkney, which were explicitly designed to cast light on this issue. Where appropriate data are available, other relevant sites (particularly Freswick Links) are also considered. The chapters investigate whether 'fish middens' actually exist (as something more than taphonomic, recovery and sampling biases), when they formed, how they relate to settlement patterns, and whether they are consistent with the production of cured fish for export.

6.10 Discussion: Continuity and change

Having considered the possible sources of wealth in the Viking Age and Late Norse earldoms in a rather synchronic light, let us conclude with a broader discussion of temporal trends. First, the Viking Age was not without wealth from beyond Orkney, Caithness and Shetland. Steatite was a ubiquitous import to Orkney and Caithness, and could conceivably also have been imported to Shetland despite local sources. Antlers or finished combs were definitely imported to Shetland (perhaps from Norway) on the basis of ecological and stylistic criteria and similar arguments may hold for Orkney and Caithness. As mentioned above, some of the Viking Age combs may be made of reindeer antler, *necessitating* import from Scandinavia. Hones are common finds, but only one, from Brough Road Areas 1 and 2, has been scientifically associated with a

Norwegian source (Batey 1989a:202, 211; Crosby & Mitchell 1987:502-503). Copper alloy sheet is rare in the Viking Age, but coins (Tables 6.6-6.7) and other distinctive metalwork are quite common. Ringed pins, oval, trefoil or equal armed brooches and mounts of various kinds are frequent finds in both settlement sites and graves. Non-metallic ornaments, such as glass and amber beads are also ubiquitous in both find contexts. The evidence for wood import is as convincing as that for the Late Norse Period. It includes, among other things, a maple handle and offcuts from pine and oak planks recovered at Tuquoy. Wood for boats - represented in graves (and implied by the bones of large gadoid fish recovered from middens, see Section 5.6) - must also have been imported.

This pattern changes little moving into the 11th century VA2/LN1 interface. Hoards continued to be left unrecovered and single finds of coins, silver and gold remain common (Tables 6.6 and 6.7). Ringed pins from Tuquoy and Freswick may date to this century (Batey 1987a:117, 144; Owen 1993:327). It is not unlikely that other personal ornaments and jewelry such as an Urnes style strap end from Freswick (Batey 1987a:108, 137) and a pin and buckle from the Brough of Birsay (Curle 1982:84, 102) do also. Glass and amber beads from Orkney, Caithness and Shetland may also date to this period of transition (if not before in the case of the poorly provenanced amber) (Batey 1987a:166; Batey & Harry pers comm.; Hamilton 1956:165).

Changes are evident, however. Hoards cease to be left unrecovered after the burial of coins and objects near Dunrossness Manse c.1065 (Table 6.6; but see Graham-Campbell 1993:176-177). Ringed pins begin to go out of fashion along with (somewhat earlier) a plethora of other elaborate personal accessories such as silver ball-type brooches (known mostly from hoards) and the oval, trefoil, and equal arm brooches known largely from Viking Age graves (see Batey 1987a:43; Fanning 1983:329; Graham-Campbell 1980:27-29 and Graham-Campbell 1983b:319-321 regarding dating of graves and artifacts). Burial without grave goods becomes the norm, evidenced by radiocarbon dated inhumations at John O' Groats (Driscoll 1990:35) and somewhat later at Murkle Bay, Caithness (Batey 1993b:160) (see Section 4.3).

Steatite vessels and antler combs remain ubiquitous imports in the 11th century and continue into the 12th (Section 6.8.2). It is difficult to know precisely when the Hardanger bakestones at Sandwick, The Biggings and Jarlshof were first imported from Norway, but the earliest Norwegian parallel is from c. 1100 (Weber 1992:162). As Bigelow (1989:188) observed, copper alloy sheet becomes common and continues to appear into the 13th and 14th centuries (Batey 1987a:120-121, 145; Batey 1986:341; Batey et al. forthcoming d; Hamilton 1956:165, 174, 181, 183, 185; Kaland

1973:99). Wood continues to be a necessary and prestigious import, given both direct evidence (such as the discovery of pine planks, probably from Norway, and cork, from the Mediterranean area, at The Biggings) and indirect evidence (such as the continued importance of fishing, implying the use of boats). Pottery makes an appearance in the 1100s, but is better represented in the succeeding centuries (Table 6.5). It is possible that whetstones continue to be imported, as Bigelow has suggested, but there is no evidence with which to assess this possibility. The only provenanced example probably moved from Shetland to Orkney (Crosby & Mitchell 1987:501-502).

At some point prior to 1137 Kirkwall developed as a market town, replacing or supplementing previous *ad hoc* markets at the farms of earls and magnates. Thurso may also have functioned as a 12th century market, but its prominence probably faded after the diocesan seat of Caithness moved from Halkirk on the Thurso River to Dornoch in Sutherland in the 1220s or 1230s (Crawford 1993:133; see Section 6.8.3).

As the 12th century became the 13th, the period in which Bigelow has suggested long range trade became a dominating force in the Shetland economy, pottery replaced steatite as the most ubiquitous import in the earldoms. A few metal and glass items of personal adornment continue to be imported (e.g. Bigelow 1984:112; Hamilton 1956:181, 183, 193), but these pale in comparison with their 10th-11th century antecedents. Wood is presumably still imported, as fish are still caught (Section 5.6). Two stray coin finds reveal a currency economy which had been hidden since hoards ceased to be left in the ground two centuries earlier (Table 6.7). Trade was well established, as the historical record for the 12th and 13th centuries reveals, but many imports must be archaeologically invisible (Section 6.8.2).

Possible fourteenth century deposits resemble their 13th century predecessors. They continue to yield imported pottery and sheet copper alloy (Batey 1986:335-336, 338; Batey et al. 1984:107, 115; Bigelow 1984:101, 111-112; Hamilton 1956:193; MacAskill 1982:407, 413; Morris et al. 1994; Owen 1993:329; Owen & Smith 1988:17). Moreover, two hoards left unrecovered during the Scottish panic of the early 14th century reveal that currency continued to circulate in substantial quantities (Table 6.6; Metcalf 1977:11). Direct historical evidence indicates that trade continued, but it is impossible to assess the potential impact of the plague which "ravaged" Orkney in 1349 (Thomson 1987:111) or of the Little Ice Age which was soon to have a significant economic impact in Iceland and Greenland (McGovern et al. 1988; McGovern 1992; see Section 2.6).

In all periods, the archaeological recognisable products are almost certainly the thin edge of a large wedge including considerable quantities of wood, grain, exotic foods and beverages, fishing lines and other tools, salt, textiles, household furniture and currency (Section 6.8.2). In exchange for these imports it is known that grain was exported by the 12th or 13th centuries at the latest (Section 6.8.4). Its availability could be substantial in good years, but non-existent in others (Section 6.9.1). Butter, wool products and cattle might also have been exported, but this is an assumption without direct archaeological or historical confirmation (Section 6.8.4). Zooarchaeological data from the few bone assemblages of reasonable quality suggest a multi-purpose herding strategy (based on the slaughter of prime cattle and sheep prior to skeletal maturity) rather than one specialised on milk or wool production (Section 5.5).

Feathers, furs and other products might also have been exported, but it is difficult to envision the considerable wealth of the earldoms (see Chapter 4) resting on hunting rabbits or on dangerous seasonal work on sea cliffs (Fenton 1978:510-523). These are best interpreted as supplementary activities of potential local importance (on Foula in Shetland, for example, where terrestrial resources are few and seabirds plentiful [Baldwin 1974]).

Other sources of wealth, such as provisioning shipping and piloting, were probably of similarly small scale - providing a useful supplementary income to all segments of society (Sections 6.6 & 6.7). Peasants could take advantage of direct payments, while earls and magnates were given the potential opportunity to collect shipping tolls (Section 6.5) or to rent onshore facilities. Provisioning may occasionally, however, have resembled unwelcome plundering - through piracy and the imposed demands of Norwegian kings on campaign.

Piracy and plunder were undoubtedly of substantial economic importance, particularly during times of expansion in the Viking Age (Section 6.2). One product of such activity, slaves, may also have provided a considerable source of wealth if traded at a putative Dublin slave market (Section 6.8.4). After the 10th and 11th centuries, however, earls fought each other, Scottish Kings and Norwegian kings to maintain their grip on a diminishing geographical and concomitant human resource (see Chapter 4). Moreover, the increasing availability of landless peasants forced to work for wages led to the disappearance of slavery by the late 12th to 13th centuries in other areas of the Scandinavian North Atlantic (e.g. Durrenberger 1988:119; Karras 1988:145, 160-163; Larson 1935:13, 26-27). It is reasonable to assume that a similar pattern characterised Orkney, Caithness and Shetland.

Plunder, particularly when used to maintain a military retinue, has been perceived as the *sine qua non* of the Viking Age (Section 6.2). It is evident, however, that this activity continued into the 12th and later centuries in the earldoms. Equally, the evidence of hacksilver, ingots and ring-money suggests that market trade was also important as early as the 10th century (Section 6.8.2). Plunder was one source of wealth among many.

Payments for military service redistributed wealth among some members of society within the earldoms and provided personal fortunes for successful mercenaries in the campaigns of Kings such as Cnut (d.1035) and Haraldr Sigurðarson (d.1066) (Section 6.4). It also provided earls and magnates with wealth from aspiring royal overlords eager to gain political allies. Although these payments are integral components of saga narratives it seems unlikely that they were regular sources of 'foreign' income. The campaigns of Norwegian kings were irregular, and probably unwelcome, events. The negative impact of Hákon Hákonarson's campaign of 1263 has been discussed in some detail above.

All of this discussion brings us to fish. I would not suggest that a putative fish trade was the only significant source of external wealth in the Viking Age or the Late Norse Period, or even that fish were the most important export commodity. It is apparent, however, that cured fish (and to a lesser extent fish oil) were staples of the Norwegian export economy from the turn of the 12th century or even considerably earlier, and of the Icelandic economy from the late 13th/early 14th century (Section 6.9.2). The historical record for Orkney, Caithness and Shetland is virtually silent, but it is silent in most regards until the 15th and 16th centuries (see Chapter 3). Moreover, a Scottish royal payment for fish from Caithness is among the few 14th century records regarding the earldoms (Burnett 1878:239).

It is at least a possibility that substantial Late Norse fish middens, such as the 13th-14th century Area A at Robert's Haven and other (some perhaps earlier) examples, represent waste from the production of cured fish for export (see Chapters 7 and 8 below). It is also a slight possibility that this trade extends deeper in time. Bigelow (1989:188-190) suggests that a 12th century increase in imported products marks the start of a Shetlandic fish trade. Zooarchaeological evidence from Orkney and Caithness (discussed in Chapter 7 below) may be consistent with a similar or even slightly later date. However, the evidence for market trade in *both* the Viking Age and the Late Norse Period discussed in this chapter sets no a-priori limits on when such an activity could have begun.

Certain aspects of the historical and archaeological record could be marshaled to support Bigelow's hypothesis. These principally include the 12th century development of Kirkwall and allusions to 12th century trade in *Orkneyinga Saga*. However, other material and logical factors are less supportive. First, imports are common in both Viking Age and Late Norse contexts. Moreover, Sandwick, the site on which Bigelow's interpretation was essentially developed, was established in the 12th century (1984; 1985:126; 1987:29; 1989:188-191). It is not possibly to demonstrate the character of earlier trade from this database. A similar caveat must be attached to the *Orkneyinga Saga*. It was composed c. 1200 and it is perhaps not surprising that references to trade cluster in the 12th century on which it focuses (Pálsson & Edwards 1981:9).

It is equally important that (excluding combs and whetstones which had been imported from the Viking Age) Bigelow's argument rests largely on the appearance of imported pottery and copper alloy sheet (probably from vessels) at Sandwick and Jarlshof during the 12th century (Bigelow 1989:188). This shift, as Bigelow (1989:188-191) and Buttler suggest, may be "relatively easy to explain in terms of an expanding market economy" (Buttler 1991:229). Alternatively, however, it can be seen as a stylistic change. This is particularly so in Orkney and Caithness where steatite was also imported. One imported vessel type (steatite) was simply replaced by another (ceramic or copper alloy).

A further tenet of Bigelow's (1989:188-189) argument, the greater number of steatite line sinkers in later phases at Sandwick and Jarlshof, may also need to be reinterpreted in light of evidence from Orkney and Caithness. As suggested in Chapter 1, it is likely that these sinkers measure the local working of steatite rather than the intensity of fishing. Many of the sinkers from Sandwick (most of which were found in the living area) were unfinished pieces in various states of manufacture (Bigelow 1985:119). In Caithness and Orkney, where faunal evidence demonstrates large scale fishing activity, but there is no local tradition of steatite working, diagnostic line sinkers are comparatively rare (see Section 5.6).

It is ironic that while Kruse (1993:199) implies a decline in Northern trade in the 11th century, based on the cessation of unrecovered hoards, Bigelow postulates the development of increasingly cosmopolitan connections 100 years later. Accepting these arguments at face value, the logical corollary would be a 'depression' of the early 12th century. This is exactly the time at which architectural and historical evidence reveals the considerable wealth of earls and magnates (see Section 4.4). Substantial portions of St. Magnus Cathedral were built in the first half of this century (Cruden 1988; Fawcett 1988) and the Bishop's Palace in Kirkwall was probably built at the same time (Simpson 1961:70-72). Despite this substantial expenditure - St. Magnus Cathedral was a project under the direct patronage of the earl - Rǫgnvaldr Kali Kolsson had the resources to support an expedition to Jerusalem in the 1150s (Pálsson

& Edwards 1981:142, 155-182). We must also envision a substantial settlement at Kirkwall before the 1130s when Bishop William decided to move the Episcopal seat from Birsay (Section 6.8.3). Turning to secular architecture, Kolbeinn Hrúga's castle on Wyre and the castle of Old Wick may also have been built in the 12th century (Gifford 1992:113; Talbot 1974). This is simply a selection, to which buildings such as St. Magnus, Egilsay, can probably also be added (Fernie 1988:159).

It would seem, therefore, that earls, magnates and the church were all quite free with the expenditure of wealth in the 12th century, including its earlier years. As argued above, hoards probably stop being unrecovered at least partially because of an outbreak of relative peace (Section 6.8.2). While internal strife was not uncommon in the 12th century, the number of powerful players may have been fewer than in previous periods. It is interesting, however, that the distribution of stray coin finds also clusters in the 10th and 11th centuries (Table 6.7). While this could be taken to support Kruse's argument one could suspect a more prosaic explanation. Six of the fourteen single coin finds come from the Brough of Birsay and Jarlshof, the most excavated sites in the earldoms. Although admittedly speculative, I suggest that additional finds akin to the single coins of Henry II (minted 1180-1189) from Upper Scalloway, Henry III (minted 1258-1272) from Freswick and Hákon V (r.1299-1319) from Baltasound will surface as more sites dating to LN2 are excavated.

Having broken the 12th century barrier, there is no *a priori* reason to suggest a single century as the likely origin of a putative fish trade. Nevertheless, Bigelow's model must not be discarded out of hand. The import of pottery of ultimate Scottish, English, German and Dutch origin may imply *increasingly* cosmopolitan trade connections, directly or indirectly through Norwegian towns. The late date of putative 'fish middens' such as Robert's Haven and Freswick Links may also be significant (see Section 7.4). Although the evidence for an unprecedented florescence of export trade in the 1100s is unconvincing, a general increase in long range (fish?) trade from the 12th to 14th centuries is entirely feasible.

Furthermore, it would be special pleading to suggest that the character of wealth had not changed in the 11th and 12th centuries as Kruse suggests. Its old media of expression, portable currency and jewelry of precious metal or bronze, were replaced by more static symbols such as castles, churches and a cathedral (see Section 4.4). It is tempting to equate this transition with the introduction of socio-economic patterns at least influenced by medieval European feudalism, involving increasingly formalised ties of magnates and peasants to the land (and, judging by the coastal distribution of Late Norse castles in Caithness, perhaps the sea). Feudal modes of land holding and letting were introduced in Scotland and (to a lesser extent) Scandinavia in the 12th century (Barrow 1981:43-44; Lindkvist 1993:188; see also Sawyer & Sawyer 1993:129-143). Although probably relevant, this argument should not be taken too far. Plunder economics still played a role in 12th century Orkney, Caithness and Shetland even if its internalised feudal variant, taxation of a peasantry (Rösener 1992:139-143), was perhaps increasingly important (compare Sections 6.2 and 6.3 above).

Having raised the *possibility* that fish provided an important source of wealth in the Late Norse Period, it remains to examine the direct zooarchaeological evidence. I do not suggest that a study of fish middens can prove the existence of an export trade in cured fish. It may be possible, however, to decide whether the data are consistent with such an interpretation.

PART III

ZOOARCHAEOLOGICAL EVIDENCE

for

FISH TRADE

Chapter 7
Fish Middens

7.1 Introduction

Zooarchaeological evidence indicates that fish were an important resource at virtually every excavated Viking Age and Late Norse site in the earldoms (see Table 5.6 and Figure 5.23). Given this background, is it justified to suggest (as I have in Chapter 1 and elsewhere above) that deposits rich in fish bone at sites such as Robert's Haven are in some way exceptional? Do identifiable archaeological features exist which merit the qualitative label 'fish midden'? Moreover, if fish middens do exist, is the scale of these deposits consistent with fishing of commercial character? This chapter addresses these two fundamental questions and goes on to consider the chronological and settlement context in which putative fish middens formed. It asks when they first occurred in the earldoms and whether they were associated with seasonal fishing stations, the informal fishing harbours of distant settlements or permanent farmsteads.

7.2 Do Fish Middens Exist?

In Chapter 1 it was suggested that midden deposits at five Late Norse sites in Orkney, Caithness and Shetland were exceptionally dominated by fish bone: Quoygrew, Sandwick, St. Boniface, Freswick Links and Robert's Haven. The first three will be considered only briefly. It is difficult to quantify the relative abundance or weight of fish bone *vis-à-vis* other classes of bone for these assemblages (see Table 5.1 and Appendix 5.1). Qualitative evidence suggests that they were anomalously rich in fish compared with other sites in the earldoms, but a definitive conclusion is not possible.

At Late Norse Quoygrew, Orkney, "a large quantity of marine shell and fish remains could be seen eroding from the deposits, as well as a lesser amount of mammal and bird bone" (Colley 1983a:208). However, only the fish bone from this site was quantified. Gerald Bigelow (1984:121, 126) excavated middens associated with a 12th-14th century dwelling at Sandwick, Shetland, some of which (particularly Midden Units 2 and 4) were characterised by "unusually pure concentrations of fish bones and molluscs." While he examined all classes of faunal remains, only a selection of fish bones was quantified. Inter-class comparison with other zooarchaeological assemblages from the earldoms is therefore impractical (see Table 5.1 and Appendix 5.1).

Recent excavations at St. Boniface, Orkney, have revealed strata dating to the 11th-13th centuries which are largely composed of ash and fish bone (Lowe 1993:30; pers comm.). Although all classes of bone have been analysed, only data regarding specimens which were identified to genus and species are presently available for the mammal assemblage (McCormick forthcoming). Inter-class comparisons are thus complicated. The proportion of fish bone by fragment count when only bones identified to genus and species are considered - 80.4% - is more comparable with settlement middens (such as Brough Road Areas 1 and 2 and Beachview Burnside Area 2) than with the putative fish midden at Robert's Haven (see Figure 5.23). However, this proportion is certain to underestimate the true abundance of marine resources as many fish bones could only be identified to the level of family (Cerón-Carrasco forthcoming; see Table 5.6). The interpretation of St. Boniface must remain ambiguous until further evidence is available.

The potential existence of specialised fish processing deposits in the Norse earldoms was first brought into focus by excavations at Freswick Links, Caithness, between 1980 and 1984. For example, Morris (1982:89) mentioned "an almost solid layer of fish bone" at Freswick in a survey of Norse settlement and economy in the British Isles. These deposits were notable for both the density of fish *vis-à-vis* other cultural inclusions and their lateral extent. Archaeological strata were intermittently observed eroding from over 150m of cliff-face in Freswick Bay (Jones et al. 1983:166, 171). The qualitative impact of the site was such that early interpretations included the possibility that "we have here evidence of fishing on a large-scale, possibly even commercially" (Batey 1989b:226).

These initial impressions have given way to more cautious statements in the forthcoming final report on excavations at Freswick Links (Morris et al. forthcoming d). Regardless of its interpretation, however, the site has yielded deposits extraordinarily rich in fish bone. Qualitative descriptions of these strata sometimes list shell and fish bone as the only faunal inclusions and include statements such as "particularly rich in fish" and "a solid layer of fish bone" (e.g. Morris forthcoming b).

It is difficult to compare quantitative data from Freswick Links with other assemblages. As explained in Section 5.3.3 above, the strategy for sorting ecofacts from sieved samples was unique. With the exception of 47 samples resorted under the author's direction, not all fish bone and shell was separated and weighed. Nevertheless, *intra-site* analysis (for which the Freswick data should be valid, see Section 5.3.3) reveals the existence of distinctive deposits composed mostly of fish bone or fish bone and shell.

Figure 7.1 illustrates the first and second axes of a correspondence analysis using the weight of shell, mammal bone, bird bone and fish bone sorted from 1016 samples collected at Freswick Links. These two axes account for 94.8% of the inertia (variability) in the data set. Pictish phases are included in the interest of completeness and to provide a chronological context for the Norse data. Hiatus strata, as defined in Figures 5.13-5.18 above, have been omitted to improve the clarity of an already cluttered figure. This approach seemed justified as these layers were probably not of cultural origin. The data were kindly provided from the Freswick excavation archive by Colleen Batey, Andrew Jones, Christopher Morris and James Rackham. Different excavation areas, as defined in Section 5.3.3 above, are indicated by symbols explained in the key.

Correspondence analysis was chosen (over principal component analysis for example) because it places data-points according to the 'shape' rather than 'size' of a row of variables (Ringrose 1988:525). That is, samples with similar proportions of inclusions are placed together regardless of differences in sample size between them. The analysis was conducted by the author with assistance from Trevor Ringrose of the Department of Mathematical Sciences, University of Aberdeen (see Baxter 1994; Ringrose 1988; 1992 for methodological discussions). Column point contributions (the degree, out of 1, to which each variable contributes to the inertia of a given axis) and representations (the degree, out of 1, to which dispersion in a given variable is represented by a given axis) are provided in Tables 7.1 and 7.2.

Variability in the weight of shell, mammal bone and fish bone is well represented by the two axes illustrated (cumulative column point representations of 0.9999, 0.9986 and 0.9999 respectively). Conversely, variability in the weight of bird bone (with a cumulative column point representation of only 0.115) plays a very small role in the position of data-points in Figure 7.1. This result is not surprising given the consistently small quantity of bird bone at the site (see Figure 5.19 for an example based on the 47 resorted samples). The dominance of three variables (coupled with the sheer number of samples) accounts for the triangular form of the data-point distribution (Ringrose pers comm.). The results are in fact similar to a triangular plot of percentage data, with high shell values in the lower left angle, high mammal values in the upper angle and high fish (and to a much lesser degree bird) values in the lower right angle. Samples in which only two inclusions are present occur along the axes, with the position dependent on the relative abundance of each.

Several features of intra-site patterning are evident from this analysis. First, a number of deposits from MCA, NCA and Area 9 - the data-points towards the lower right hand corner of the figure - are almost entirely composed of fish bone. Bird bone also lies in this direction, but as just discussed it has a very tiny effect on the first two axes. The only notable impact of high bird bone values is to produce the two outliers in the extreme lower right. They represent samples high in both fish and bird bone.

Secondly, the vast majority of samples from MCA and NCA are stretched along axis 1, indicating that they contain both shell and fish bone, but very little mammal bone. Many samples particularly high in shell *vis-à-vis* other cultural inclusions were probably from natural sand accumulations (see discussion of Robert's Haven below). However, some shell was probably cultural in origin and, based on ethnohistoric analogy (Fenton 1992), may have been collected for use as fish bait.

Thirdly, as Rackham (forthcoming; see also Morris et al. forthcoming b) has observed, *some* samples from MCA (and also Area 9) have large proportions of mammal bone. They have higher values on axis 2 and thus occur towards the middle (or in a few exceptionally mammal rich samples, the top) of the scatter-plot. Conversely, samples from NCA are notable absent from the upper apex of Figure 7.1. It is possible, as Rackham has suggested, that *some* strata from MCA (in which structural remains were also found) are associated with domestic rubbish disposal rather than with fish processing. A similar interpretation could be offered in reference to Area 9. The possibility must also be considered, however, that taphonomic processes have inflated the relative weight of mammal bone in these samples by differentially destroying fish bone (Jones et al. 1983:173; see Section 5.2.2). For example, trampling activity might be greater in the vicinity of a dwelling. This issue will be pursued further below.

Finally, the (essentially) Pictish samples of SCA and the poorly dated samples from Area 3 are largely dominated by shell and/or mammal bone. They provide a distinct contrast to most Norse samples, but are not of present interest. Rackham (forthcoming) and Morris et al. (forthcoming b) suggest that their composition reflects a combination of economic behaviour and dune erosion processes.

The Freswick data imply both that Late Norse 'fish middens' exist, and that they can perhaps be contrasted with domestic deposits less dominated by marine resources. A similar interpretation is suggested by results from the author's investigations at Robert's Haven. Figure 7.2 illustrates the first two axes of a correspondence analysis of the same variables considered regarding Freswick: shell, fish bone, mammal bone and bird bone. In this case, however, all fragments retained by a 4mm mesh have been sorted and weighed (see Section 5.3.2). The axes considered account for 99.0% of the inertia in the data set. Labels, explained in the key of Figure 7.2, indicate both excavation area and phase. Column point contribution and representation values are provided in Tables 7.3 and 7.4.

The results are broadly similar to Freswick. First, a number of virtually bone free samples cluster around shell in the left corner of the figure. These include sterile layers of shell sand (e.g. samples 2001, 2024 and 7024) and strata dominated by carbonised vegetation and shell sand (e.g. samples 7008, 7014 and 8004). Cultural shell dumps such as samples 1008 and 3010 - possibly associated with bait preparation - are also moderately rich in fish bone and thus have higher values on axis 1.

Most samples from Area A cluster along axis 1, with their position dependent on the relative proportion of shell (lower values on axis 1) and fish bone (higher values on axis 1). All samples from Areas E and B have low values of fish bone and some are drawn along axis 2 by a high proportion of mammal bone. Bird bone, with a cumulative column point representation of 0.308 on the first two axes, has relatively little effect on the data-points in Figure 7.2. By plotting the second and third axes, however, it is evident that bird bone is only abundant in a few samples from Area A (Figure 7.3). Based on the spatial association of manx shearwater wing bones during excavation it is possible that these represent strata which once contained partially articulated individuals.

If shell is omitted from consideration, the three classes of bone can be compared by simple use of triangular plots. Figures 7.4-7.7 display the relative proportion of mammal, bird and fish bone by weight in each area at Robert's Haven. Only samples from Area B (which belong to both Late Norse and post-medieval phases) have been subdivided by phase.

It is immediately apparent that virtually all samples from Area A yielded over 80% fish bone by weight (Figure 7.4). Area E (Figure 7.7) presents a quite different pattern, with mammal bone constituting from 42% to 75% of each sample and fish bone rising above 40% in only two samples (excluding four outlying samples each of which contains less than 1g of bone; see Appendix 7.1). Area B lies between these extremes, exhibiting a wide range in the relative proportion of mammal and fish bone in both early and late phases (Figures 7.5-7.6).

The fundamental difference between these areas is also illustrated by considering the density of bone inclusions (Figures 7.8-7.11). The samples of Area A have a mean of 13.28 grams of bone per litre of sediment, with no obvious breaks in a distribution from less than 1g/l to 33.91g/l (Figure 7.8). This range expresses variability in the intensity of bone dumping *vis-à-vis* the accumulation of other sediment, principally shell and wind-blown sand. Two samples with much higher densities, 1005 and 1006, derive from a single stratum - context 1005 - almost entirely composed of fish bone (see Appendix 7.1 for a concordance of contexts and samples from Robert's Haven).

Conversely, the probable Late Norse samples of Area B have a mean of 1.01g/l with all but one sample containing less than 2.02g/l (Figure 7.9). The one anomaly, sample 7019 at 9.20g/l, is still at the lower end of the distribution evident in Area A. Area E exhibits a pattern similar to Area B, with all samples having less than 1.12 grams of bone per litre of sediment except a single outlier with 4.52g/l (Figure 7.11). In this case, the outlying sample represents what may be undisturbed midden. The others derive predominately from overlying plow-zone and underlying subsoil.

How might this evidence be interpreted? First, it is evident that each area at Robert's Haven developed through different depositional and/or post-depositional processes. It may be reasonable to interpret Area A as a semi-specialised deposit created by the disposal of bait and fish processing waste. The variable proportions of mammal, fish and bird bone in Area B may represents a variety of feature types created by slightly different past activities. It is also likely that the low density of bone in these deposits, and therefore the tiny quantity per sample, has contributed to the somewhat erratic picture in Figures 7.5-7.6. It must be stressed, however, that this low density itself marks a significant distinction between Areas A and B. Area B is not a fish midden.

Area E is less diverse than Area B. It may be reasonable to suggest that it is a single deposit, with less bone-rich upper strata disturbed by plowing. The low proportion of fish compared to Area A could be interpreted as either a behavioural pattern (possibly related to household consumption rather than fish processing) or a product of differential preservation (assuming greater exposure to trampling phenomena in the vicinity of the structure).

In summation, patterns at Robert's Haven and Freswick Links are relatively clear. Distinct archaeological deposits - including fish middens - do exist. For purposes of direct comparison it is possible to use data regarding the 47 samples from the Northern Cliff Areas at Freswick which have been resorted. The proportion of fish bone by weight (62.4% to 98.6% with most samples in the upper end of this range) is similar to results from Area A (the fish midden) at Robert's Haven (compare Figures 7.4 and 7.12). The density of bone in grams per litre (Figure 7.13) is less than at Area A, but much greater than at Areas B and E.

Although fish middens exist, an important complicating factor has also emerged from investigation of intra-site patterning at Freswick Links and Robert's Haven. It is necessary to consider whether apparent differences between fish middens and putative domestic rubbish deposits could be a product of differential preservation. This problem can be addressed to some degree using measures of taphonomic attrition.

The degree of fragmentation in mammal bone assemblages from Freswick Links was assessed by Gidney (forthcoming). She employed a system developed by James Rackham in which each bone is divided into from one to 10 diagnostic zones. The number of zones present on an archaeological specimen is used as an index of how fragmented it is (with mean values facilitating inter-assemblages comparisons). An index value of 1 indicates an average of one diagnostic zone per fragment. Lower values indicate greater fragmentation and vice versa.

Table 7.5 illustrates the resulting data from the main excavation areas at Freswick Links. Preservation - of mammal bone at least - is actually better in the Middle Cliff Areas than in the Northern Cliff Areas. If increased fragmentation were responsible for the lower ratio of fish to mammal bone in some samples from MCA one would expect the opposite. Some data regarding fish bone preservation also exist for the Freswick assemblage (Jones et al. forthcoming b). However, they do not include the Middle Cliff Areas of present concern.

Soil thin section micromorphology casts some light on site formation processes in Areas A and B at Robert's Haven (Simpson & Barrett forthcoming). Neither area has yielded evidence of post-depositional disturbance which might explain the difference in fish bone content. In fact, Simpson and Barrett (forthcoming) conclude that the sediments of Area B probably accumulated more continuously, and suffered less pedoturbation, than those of the Area A 'fish midden'. Ploughing probably comminuted bone in the upper strata of Area E. However, deeper layers (particularly context 5005, including samples 5008-5010) appeared to be relatively undisturbed. It is also notable that the pH of all three areas at Robert's Haven is neutral to basic (Appendix 5.2). Chemical processes are unlikely to explain intra-site differences in bone preservation.

More detailed consideration of bone survival in different deposits at Robert's Haven must await complete analysis of the faunal assemblages from areas B and E. Dating evidence from these areas was not available until late in the current project. They were therefore passed over in order to analyse the fish bone from Late Norse phases of another assumed domestic site - Earl's Bu, Orkney.

As discussed in Chapter 5, the fish bone from Earl's Bu was studied to provide a probable domestic assemblage to contrast with the possible fish processing midden at Robert's Haven. It's domestic character was originally assumed on several bases. First, it is set back c. 200m from the shore. Other possible fish processing deposits (such as Quoygrew, Sandwick, Freswick, Robert's Haven and St. Boniface) have all been coastal. Second, the middens at Earl's Bu were immediately adjacent to structures and a chapel of assumed Late Norse date (Batey 1993a; Batey & Morris 1992; Fisher 1993; Morris et al. 1994). Third, the site is associated with 12th century elite *settlement* in *Orkneyinga Saga* (Pálsson & Edwards 1981:99, 125, 195) an association which may be strengthened by the recovery of a gold fragment (Batey & Harry pers comm.). Fourth, and most immediately relevant, shell (common in other fish middens) is virtually absent from the site and mammal bone constitutes 86.5% of the currently analysed bone assemblage by weight (see Table 5.13 and Figure 7.15). A correspondence analysis of raw shell and bone weight (Figure 7.14) and a triangular plot of percentage bone weight data (Figure 7.15) from Earl's Bu do illustrate that some strata were rich in fish bone (data from Mainland pers comm. and this study, see Appendix 7.2). However, the proportion of fish in the most extreme examples barely overlaps with the distributions from Robert's Haven Area A and Freswick Links NCA (compare Figures 7.4, 7.12 and 7.15).

Using the faunal assemblage from Earl's Bu as an example of household consumption waste, it is possible to consider whether it differs from fish middens such as Area A at Robert's Haven for taphonomic or behavioural reasons. Several lines of inquiry are helpful in this regard. First, it is relevant to compare sediment conditions at each site. Appendix 5.2 tabulates pH determinations for a variety of contexts taken using dried soil samples and deionized water in a ratio of 1:1. As shell and bone are both susceptible to destruction in acidic soil conditions (Linse 1992; Stein 1992:138) it is reasonable to consider whether the calcareous sands of Robert's Haven were responsible for better preservation than clay rich sediments excavated at Earl's Bu.

The difference in soil conditions has had some noticeable impact. Otoliths (principally composed of calcium carbonate) did not survive at Earl's Bu and (by implication) shell may also have been affected. However, although pH is generally higher at Robert's Haven (with a range from 7.1 to 8.8), the sediments of Earl's Bu (with a range from 6.6 to 7.7) are not acidic. The chemical diagenesis of bone is a complex process (Hedges & Millard 1985), but it may not be unreasonable to suggest that soil conditions alone are unlikely to account for the dramatic difference between the two assemblages.

It is also possible to compare the degree to which fish bones at Robert's Haven and Earl's Bu have suffered physical damage. This has been done in two ways. First, the nine diagnostic elements routinely identified to species at both sites (see Section 8.3.2) were qualitatively scored on a five point completeness scale (0-20%, 20-40%, 40-60%, 60-80% and 80-100%). Figures 7.16 to 7.20 illustrate frequency distributions of the resulting *completeness scores* for the major taxa at each site.

Only cod is sufficiently abundant at both sites to facilitate direct comparison. Qualitative assessment of the results suggests that several bones have suffered more damage at Earl's Bu than at Robert's Haven. These elements are the articular, posttemporal, premaxilla and vomer. The remaining five elements exhibit comparable preservation patterns.

It is also possible to predict the complete dry weight of two cod bones (premaxillae and dentaries) from linear measurements taken on clean archaeological specimens which retain the robust measuring points (illustrated in Figure 8.1). The predicted complete weight of each measurable premaxilla or dentary can then be divided into its actual dry weight to produce a ***bone weight survival estimate***. The resulting data can facilitate statistical comparison of the degree to which different fish assemblages have been influenced by processes which affect bone weight - physical fragmentation, biological attack and chemical dissolution (Lyman 1994:354-403; see Section 5.2.2).

The regression equations relating linear bone measurements and element weight were determined by least-squares regression analysis of $\log_{10}$ transformed data from 54 modern reference specimens (see Figures 7.21-7.24). The mean of measures from paired left and right elements was used to avoid the problem of autocorrelation (Shennan 1988:154). The resulting equations (linear measurements D1, D2, P1 and P2 taken to 0.1mm and element weight taken to 0.001g) are:

Dentary Weight (g) = $0.00697(D1)^{3.062}$ (r^2=0.979, p=<0.001)
Dentary Weight (g) = $0.00791(D2)^{2.947}$ (r^2=0.976, p=<0.001)

Premaxilla Weight (g) = $0.00143(P1)^{2.914}$ (r^2=0.968, p=<0.001)
Premaxilla Weight (g) = $0.00447(P2)^{2.953}$ (r^2=0.957, p=<0.001)

Reference skeletons were prepared by water maceration or maggot digestion without subsequent degreasing. The potential impact of lipid content on the weight of gadoid bones is likely to be small (c.5% or less [Nicholson 1991:53]). Cod were chosen as they are the most common single taxon at both Robert's Haven and Earl's Bu. Measurements D2 and P1 were always preferred to predict *bone weight survival estimates* - due to the ease with which the measuring points could be consistently located. However, D1 and P2 were used where necessitated by breakage or erosion of the preferred measuring locations.

The *bone weight survival estimates* obtained using this second method are illustrated in Figures 7.25-7.28. They can be assessed qualitatively and statistically. Visually, the dentaries would appear to be similarly preserved at Earl's Bu and Robert's Haven (although there is a suggestion of bimodality among data from the latter site which will be considered in Section 8.3.5 below). This impression of inter-site similarity is confirmed by a one-tailed Mann-Whitney test. The hypothesis that dentaries from Robert's Haven are better preserved is rejected at the 0.05 significance level. The Mann-Whitney test was chosen over potentially more powerful alternatives (such as a *t*-test) because the data are not normally distributed (Minitab Inc. 1991:10-7).

Unlike the dentaries, premaxillae do appear to have lower *bone weight survival estimates* at Earl's Bu than at Robert's Haven (Figures 7.27-7.28). This interpretation is consistent with the less precise *completeness scores* (Figures 7.16 and 7.19). Moreover, it is supported by a Mann-Whitney test of the samples. The hypothesis that premaxillae are better preserved at Robert's Haven than at Earl's Bu is significant at the 0.01 significance level.

This variability between different skeletal elements obviously complicates interpretation. Nevertheless, some bones are less well preserved at Earl's Bu than at Robert's Haven while none are better preserved at the former site. It may thus be reasonable to suggest that, on the whole, the fish bone from Earl's Bu has suffered more physical attrition. The high proportion of haddock at this site could be interpreted in a similar light. Haddock cleithra and posttemporals are particularly robust due to hyperostosis (von den Driesch 1994:37-38). As discussed in Section 8.5 below, however, this species is also well represented by elements with less anomalous preservation characteristics.

If fish bone is less well preserved at Earl's Bu the possibility must be entertained that differences between the two sites is an artifact of taphonomic patterning. As discussed in Section 5.2.2, mammal bone is less susceptible to physical damage than fish bone (see Jones 1991a:94; Nicholson 1992a). Thus, destructive processes are likely to have a net effect of decreasing the proportion of fish in a mixed assemblage.

The key question, however, is whether the difference in fish bone preservation at Robert's Haven and Earl's Bu is sufficient to explain the overwhelming gulf between the faunal assemblages? Regrettably, there is no direct way to extrapolate from the damage suffered by particular fish bones to the degree of bone loss in an entire assemblage. To do so would require four assumptions, all of which are definitely or probably untrue:

1) That the relative difference in bone weight loss between sites is similar for each skeletal element. This is likely to be untrue, given the probability that different bones react to taphonomic processes in different ways. The difference in preservation between dentaries and premaxillae at Robert's Haven and Earl's Bu underscores this problem.

2) That fragments from the margins of measured premaxillae and dentaries are completely destroyed and thus unweighed. Otherwise *bone weight survival estimates* could overestimate the degree of bone destruction in an assemblage as a whole.

3) That no premaxillae or dentaries become unmeasurable (by erosion or breakage of the measuring points). Unmeasured bones could also make *bone weight survival estimates* overestimates of bone destruction at the assemblage level.

4) That no premaxillae or dentaries are completely destroyed. Otherwise, *bone weight survival estimates* could underestimate the total degree of bone destruction.

Despite these caveats, it is tempting to use the largest difference between mean *bone weight survival estimates* (from premaxillae in this case) as an ad hoc indication of the relative difference in total assemblage weight loss. If this were done, the proportion of fish bone in the Earl's Bu assemblage might rise from 13.0% to c.21% by weight - still far below the proportion of fish at Robert's Haven (97.3%). The procedure is uncomplicated (EB, RH and BWSE indicate Earl's Bu, Robert's Haven and *bone weight survival estimate* respectively):

$$\text{'Corrected' EB fish weight} = \frac{(\text{RH mean BWSE}) \times (\text{original EB fish weight})}{(\text{EB mean BWSE})}$$

$$\text{'Corrected' EB fish weight} = \frac{(80.2) \times (3471.1)}{(56.6)}$$

'Corrected' EB fish weight = 4918.4

$$\text{'Corrected' EB \% fish} = \frac{\text{'Corrected' EB fish weight}}{\text{original EB mammal and bird weight}} \times 100$$

$$\text{'Corrected' EB \% fish} = \frac{4918.4}{23170.3} \times 100$$

'Corrected' EB % fish = 21.2%

While the 'corrected' value of c.21% fish bone by weight is nothing more than an informed guess, it may suggest that the difference between Earl's Bu and Robert's Haven is not entirely a product of taphonomic bias. Even discounting this speculative model it seems highly unlikely that taphonomy alone could account for the difference between 13.0% fish bone by weight and 97.3% fish bone by weight - particularly given that some elements were similarly preserved at both sites and identical recovery strategies were used.

In summation, the available evidence would suggest that distinct deposits at both Freswick Links and Robert's Haven are anomalously rich in fish bone. They stand in stark contrast to broadly contemporary assemblages, possibly representing household consumption rubbish, which contain much more mammal bone. Possible taphononomic contributions to this pattern demand further study. However, the tentative investigations pursued above suggest that fish middens are a feature of past human behaviour rather than differential preservation.

It is not possible at present to extrapolate these results to other potential fish middens in the earldoms. As discussed above, the relative proportion of mammal, fish and bird bone cannot be compared at sites such as Quoygrew, Sandwick, and St.Boniface. Measures of taphonomic attrition are also unavailable for these assemblages. Deposits similar to the fish middens at Robert's Haven and Freswick Links may exist elsewhere in the earldoms - as qualitative description of these sites suggests. However, further research using comparable methods is necessary to confirm this possibility.

7.3 The Intensity of Fishing at Robert's Haven

7.3.1 Introduction

Having established that fish middens exist, it remains to consider whether the scale of these deposits is consistent with activity of commercial character. This is a difficult problem for which a definitive solution is unrealistic. Nevertheless, an attempt to reach a conclusion can provide valuable insights into the possible character of Late Norse fishing activity.

Detailed information is only available regarding Robert's Haven. To reconstruct the intensity of fishing represented by this deposit (in terms of fish per year for example) it is necessary to model the duration of sediment accumulation, the homogeneity of the midden, the original total volume of the deposit, the number of fish represented in the excavated area and the number of fish bones lost through taphonomic processes. Each of these variables can only be estimated in the most general of terms.

7.3.2 Duration of Sediment Accumulation

Several lines of evidence suggest that accumulation was relatively rapid in Area A at Robert's Haven. First, stratum boundaries were distinct and inclusions (principally fish bones and shells) were oriented parallel with the natural bedding plane of each context. The layers did not exhibit the mixing associated with soil homogenization (Stein 1992:136). This pattern is illustrated particularly vividly by the recovery of 207 groups of articulated fish vertebrae, fin rays, scales and skull bones.

The evidence of terrestrial mollusc analysis suggests a similar interpretation. Twenty samples (recovered from the flot of a modified Siraf tank using 0.5mm mesh, see Section 5.3.2) were examined by Terry O'Connor and Judith Turner of the University of Bradford (pers comm.). The samples analysed were chosen to represent a variety of context types, ranging from sterile calcareous sands (e.g. sample 2024) to peaty clays with a high density of cultural inclusions (e.g. sample 3011). Samples from all strata examined by soil micromorphology were also studied in order to facilitate the direct comparison of results.

In all but two cases, the samples were characterised by very low concentrations of land snails and by facultative carnivores of the genus *Oxychilus* which can rapidly colonise disturbed ground and take advantage of food debris. This observation is consistent with rapid midden accumulation, preventing the establishment of a stable soil horizon and a concomitant colonisation by open grassland taxa such as *Clausilia bidentata*, *Cochlicopa lubrica*, *Lauria cylindracea*, *Vallonia excentrica* and Zonitids. The two exceptions, samples 3018 and 3020, had higher numbers of these species, suggesting that the strata from which they derived were exposed land surfaces long enough for colonisation to occur. Soil micromorphology tells a similar story of generally rapid accumulation - with some short-term episodes of non-deposition (see Simpson & Barrett forthcoming and Section 7.5 below).

Radiocarbon dating is not inconsistent with this evidence, but does suggest a moderately rapid rather than extremely rapid rate of accumulation for the exposed portion of the midden. The lowermost dated stratum, (sample 2011 from context 2012) provided a calibrated date of A.D. 1172-1266 (one sigma range) while the uppermost (sample 2018 from context 2017) was dated to A.D. 1288-1412 (one sigma range). Taking the mollusc, soil and ^{14}C evidence together, accumulation over a century does not seem unreasonable.

7.3.3 Intra-deposit Variability

In order to assess the amount of fish represented by the entire Area A midden it is necessary to assume that it is relatively homogenous. As only three sample columns 50cm x c.75cm in dimension were excavated, it is important to consider the likelihood that they are representative of the deposit as a whole.

There is reason to assume that it is valid to treat the fish midden as a single feature type and analytical unit. Survey and excavation suggest that the midden accumulated rapidly and represents a relatively consistent range of past activities. The arguments in favour of rapid accumulation have just been discussed in Section 7.3.2. Evidence which suggests that the midden is relatively homogenous is equally convincing.

On initial inspection of the Area A midden similar cultural inclusions could be recognised in the entire exposed section. The deposit *was* composed of multiple lenses with varying concentrations of sand, fish bone, shell and other inclusions. The only radical stratigraphic breaks, however, were layers of windblown sand which could represent very short-term events (see Lamb 1991:18-19).

Excavation has generally confirmed this impression of homogeneity. Sixty-one excavated samples from the three widely separated sample columns are remarkably similar. Bone, the most common inclusion of human origin (many elements exhibit evidence of burning and butchery), provides a useful index with which to begin. Figure 7.4, introduced above, illustrates the relative proportion of fish, mammal and bird bone by weight in samples from Area A.

Most samples from this area (55 of 61) contained minute quantities of mammal and/or bird bone and virtually all of them yielded over 80% fish bone by weight. All but five actually included greater than 90% fish bone. Turning to other inclusions the pattern is less striking, but similar in implication. Virtually every sample also yielded shell (all 61 samples, although some of it could be naturally deposited), carbonised vegetation (all 61 samples, principally burnt peat) and pottery (48 samples).

Variation does occur within the deposit. As illustrated in Figures 7.29 to 7.31, the relative density of different inclusions (measured as grams of material per litre of excavated sediment) varies from sample to sample in each excavated column. In the case of trace inclusions such as mammal and bird bone this is not surprising. Conversely, it is clear that shell and fish bone, both extremely abundant, were not always deposited in consistent proportions. Given the excellent resolution of many layers (seldom more than a few centimetres thick) this pattern can probably be interpreted as the result of related activities separated in time - the processing of bait and fish respectively (see Fenton 1992 for a discussion of the use shellfish as bait). This interpretation is shown in sharp relief by two stratigraphic contexts (each excavated as two superimposed samples) in Column A. Samples 1005 and 1006 derived from a lens of partially articulated fish skeletons. Most were of a single species (cod represented 217 of 257 gadoid fragments identified to genus or species) and a single size category (152 of 207 fragments for which size could be estimated came from cod of 800-1000mm in total length). It is entirely possible that they arrived on site as a single catch given the tendency for cod to form shoals (Whitehead et al. 1986a:686). Conversely, the underlying two samples (1007 and 1008) derive from a single context dominated by limpet shells.

The quantity of carbonised vegetation also varies independently from most other inclusions. It is, however, weakly correlated with fish bone (r=0.75, note that actual weight, not g/l, was used for this calculation, see Atchley 1976). The degree to which changes in the density of carbonised vegetation can mirror analogous changes in fish bone is particularly visible in Columns A and C (Figures 7.29 and 7.31). Given the high resolution of excavation, this pattern suggests that they were often added to the midden simultaneously. Two possible explanations can be suggested: either the rendering of oil from fish livers nearby (which can be done by heating them in water, see McGregor 1880:145-146) or the spreading of ash/midden material on discarded fish waste to mask the odour and deter scavengers. The latter seems more likely given the ubiquitous presence of charred cereal grain in the samples (Huntley pers comm.; see Figures 7.35-7.37).

The Area A sampling strategy does not adhere to the principles of strict statistical legitimacy. A statistically justified inference that the fish midden is homogeneous would require a large number of excavation units placed evenly or randomly over the entire surface of the deposit or even complete excavation (see Casteel 1976 and papers in Mueller 1975). It was impossible to meet or even approach these conditions. Some of the midden was removed by erosion prior to excavation and only the exposed face of the remainder could be sampled. The landward extent of the deposit was still covered with an unstable overburden of 2-3m of wind-blown sand. Nevertheless, it is tempting to suggest that patterns consistently observed in 61 samples from three widely separated locations are representative of the midden as a whole. It is easier to accept this assertion when 28m of exposed deposit provided qualitative confirmation that characteristics such as the predominance of fish bone vary little (at the macro-scale) throughout the length and thickness of the midden. This does not deny, as discussed above, that differences of degree exist between samples. This pattern is to be expected given the high resolution evident in many stratigraphic contexts.

Area A at Robert's Haven is not a complex 'farm mound' composed of structural remains and soil accumulations from many activities (e.g. Bertelsen & Lamb 1993:545). It is a palimpsest of rubbish from many related events. Results regarding the three sample columns may thus be a valid estimate of characteristics of the midden as a whole.

7.3.4 Total Midden Volume

Having suggested that estimates of fish abundance from the excavated area can probably be extrapolated to the midden as a whole it is necessary to predict the total volume of the latter. This procedure is extremely unreliable and must be treated only as a heuristic exercise. It is necessary to assume that reasonably appropriate dimensions can be predicted for the entire midden based on the cross section exposed in the wave cut bank. The easiest way to achieve such an estimate is to assume a symmetrical semi-spherical deposit (resembling a slice removed from the surface of a sphere) with a basal diameter equal to the length of exposed midden and a height equal to the deposit's maximum thickness. This approach can be used to predict a hypothetical volume, which (in combination with data from the sample columns) can then be used to estimate the total quantity of fish bone the midden might have contained prior to erosion. John Nimmo of the Department of Mathematics, University of Glasgow, kindly provided the necessary equation (where h is the height and r the basal radius of our ideal symmetrical midden):

$$\text{Volume} = \frac{\Pi h}{6} \times (h^2 + 3r^2)$$

Based on a maximum measured thickness (height) and linear extent (basal diameter) of 1.3m and 28m respectively it yields an estimate of 401.4 metres^3 or 401400 litres. The irregularity of the midden, and uncertainty as to its true horizontal extent, ensure that this figure will be wildly inaccurate.

7.3.5 The Number of Fish Represented

The minimum number of cod family fish represented in the excavated columns - based on the single most abundant gadoid element, the parasphenoid - is 258. The total volume of sediment excavated from Area A was 915.5 litres. The number of gadoid fish represented by each litre of sediment is thus 0.282. This value could be multiplied by the estimated midden volume of 401400 litres to approximate the number of fish represented in the deposit as a whole. However, it is first necessary to consider the degree to which the *archaeological assemblage* of fish bone (that material recovered for analysis) is a biased representation of the original *death assemblage* (the bones of all fish originally captured) (see Section 5.2.2). Experimental and ethnographic observations confirm that a wide range of pre-depositional and post-depositional taphonomic processes ensure that the difference between these two assemblages will be considerable.

Given the rapid burial of fish bones at Robert's Haven (best illustrated by the 207 examples of bones recovered in anatomical articulation) post-depositional factors may have played a relatively minor role at this site. The difference between death and archaeological assemblage is likely to be less here than in most archaeological deposits. Nevertheless, pre-depositional processes ensure that a considerable loss of material is likely to have occurred. Some bones were probably disposed of in hearths or fed to carnivores (perhaps dogs) prior to final deposition in the fish midden. In total, 1984 gadoid fragments exhibited evidence of burning, 67 of gnawing by carnivores, 266 of crushing and 103 of partial digestion. Amorphous material identified as coprolites, some of which included fragments of bone, also occurred in 17 contexts (see Section 8.3.5 below). More importantly, it is highly likely (based on ethnohistoric analogy) that some fish waste was disposed of at sea (Colley 1986:35) or used for fodder (Vollan 1974:507) and agricultural fertiliser (Withrington & Grant 1979[1791-1799]:244). Significant scavenging by seabirds is also highly probable.

While there is little doubt that the archaeological assemblage at Robert's Haven significantly underestimates the death assemblage, there is no direct way to estimate the degree of bias. Some experimental work, admittedly without rapid burial, suggests survival rates of less than 10% for mammal bone (see Section 5.2.2). Moreover, a single experiment with fish bone, by Bullock and Jones (Jones 1990:114), produced a recovery rate of less than 1%. In the absence of better analogs, survival estimates of 1% and 10% will be used as working figures for the present exploratory exercise.

All of the assumptions and predictions made above are likely to be somewhat or even (in the case of midden volume and bone survival estimates) wildly inaccurate. Any predictions of the number of fish represented by Area A at Robert's Haven will thus be highly unreliable. Nevertheless, they could provide a useful starting point from which to interpret the potential intensity of fish processing activity at Robert's Haven. It would be interesting to know, for example, the order of magnitude implied by the deposit. Assuming accumulation over a century, should we envision 100, 1000, 10000 or 100000 fish processed per year?

Assuming that the density of fish bone is constant throughout the fish midden, simple arithmetic produces an estimate of c.113120 fish in the entire deposit, or c.1131 fish per year assuming a century of accumulation. Given the probability of large scale bone loss prior to burial, this figure should perhaps be interpreted as 1/10th to 1/100th of the original number of fish processed.

I hesitate to derive this estimate as anything other than a heuristic device. It is unequivocally inaccurate. Nevertheless, it illustrates the potential scale of fish processing activity at Robert's Haven. If other bays around the coast were used in similar ways, as seems likely given the results from Freswick Links (and possibly other sites such as Quoygrew, Sandwick and St. Boniface) the quantity of cured fish produced in the Norse earldoms could have been substantial.

7.3.6 The Intensity of Fishing

Two analogies from post-medieval Shetland provide a scale with which to assess these results. First, one of the best commercial fishing stations of the 18th century was responsible for a catch of 50000 fish per year. This station (Northmavine) had 100 boats while others, such as Funzie in Fetlar, were much smaller (Fenton 1978:573). If the estimates derived for Robert's Haven are at all accurate, the magnitude of fishing *may* have been comparable with Northmavine (and was almost certainly comparable with smaller stations such as Funzie).

Second, in the 17th century Hanseatic merchants sailed to Shetland annually to trade directly with local peasants and fishermen. If a similar pattern existed in the Late Norse Period there would be no need to expect waste from fish processing for export to be concentrated at a single highly specialised site. Instead, one could envision a number of smaller processing stations such as Area A at Robert's Haven and NCA (and parts of MCA and Area 9) at Freswick Links. Moreover, fish could be processed and cured throughout much of the year. The residue from each fishing event could be small, while still culminating in a significant stockpile for annual export. This is an important point, as Morris et al. (forthcoming b) have recently suggested that the number of large gadoid fish represented in each sample at Freswick Links is small enough to be consistent with local use. As some of these samples were thought to represent the waste from a single catch (and all represent only portions of much larger middens), it is equally possible that the scale of fishing at Freswick is consistent with an export trade.

The discussion hitherto does not prove that fish processed at Robert's Haven or Freswick Links were exported. It may, however, suggest that the scale of activity was consistent with this hypothesis. Sections 7.4 and 7.5 below develop the interpretation of fish middens by considering their chronological and settlement context. Explicit argument for the export hypothesis is returned to in Chapter 8, where the fish bone assemblage from Robert's Haven is considered in some detail.

7.4 When did Fish Middens Develop?

If fish middens exist, when did they begin to form? As just discussed, the evidence from Robert's Haven probably spans only c.100 years in the 13th and/or 14th centuries. At Freswick Links, the best dated deposits are attributed to pre-Norse, Pictish, occupation and to the last few centuries of the Late Norse Period - particularly the 13th century (Morris et al. forthcoming b; see Figures 5.13-5.18). Deposits broadly dated to the Late Norse Period and to the Viking Age or the Late Norse Period may represent the intervening centuries, but there can be little certainty of this.

The position of samples rich in fish bone within the dating framework for Freswick Links is illustrated by Figure 7.40. It presents the same results as the correspondence analysis introduced in Section 7.2 above. In this case, however, the data-points for each sample are labeled by period rather than excavation area. It is evident, as implied above, that Pictish layers are dominated by mammal bone (in the top apex of the figure), that many Late Norse, including LN2, samples are dominated by fish bone or by fish bone and shell (the lower right apex or between the lower two apexes) and that samples from both periods are abundant in shell (the lower left apex). As discussed in Section 7.2, the Late Norse samples towards the middle and top of the figure - rich in mammal bone - are mostly from the vicinity of structural remains in MCA. This figure highlights the fact that the only *tightly dated* fish midden deposits (those high in fish bone or both fish bone and shell) at Freswick Links can be attributed to LN2.

Robert's Haven and Freswick Links thus provide firm evidence for the existence of fish middens only in the 13th-14th centuries. The three other possible fish midden sites - Quoygrew, Sandwick and St. Boniface - provide little additional information. Quoygrew is the least informative. It can only be broadly dated to the Late Norse Period (Colley 1983a:209; see Section 3.5). Evidence from Sandwick is consistent with Robert's Haven and Freswick Links. The deposits most dominated by fish bone probably belong to the 13th-14th centuries (Bigelow 1984:121, 126-127). Earlier evidence is only forthcoming from St. Boniface. Basal strata of phase 8, possibly a 'fish midden', have yielded calibrated radiocarbon dates of A.D. 1010-1185 and A.D.

990-1240 (Lowe 1993:30). If St. Boniface proves to be analogous to Area A at Robert's Haven, this site may suggest that fish middens occurred as early as the 11th or 12th century. It would be unwise to rely on this interpretation, however, in the present absence of data which could facilitate unbiased inter-class comparisons (see Section 7.2 above).

No other Viking Age or Late Norse sites are dominated by fish bone to a degree comparable with Robert's Haven and Freswick Links (see Tables 5.5-5.7 and Figure 5.23). Fish is extremely abundant at the Beachview sites when measured by fragment count, but weight data illustrate that this is an artifact of the extremely fine mesh (0.895mm) used for recovery (see Table 5.13). The retention of many tiny unidentified fragments inflates the abundance of fish *vis-à-vis* mammals and birds (see Section 5.6). Given the current evidence it is thus possible to suggest that fish middens are only known to occur in the 13th and 14th centuries. Eleventh or 12th century deposits at St. Boniface may suggest an earlier origin, but all the data necessary to interpret this site are not yet available.

If fish middens are equated with processing for export, as tentatively suggested above, the *naissance* of this trade can be dated no earlier than the 13th century on the basis of present zooarchaeological evidence. As discussed in Section 6.10, however, the earldoms were probably engaged in long range market trade from the Viking Age. Moreover, circumstantial evidence such as the presence of Orcadians at the fish entrepôt of Grimsby in the 12th century could suggest an earlier participation in fish trade.

Given this discrepancy, it is tempting to consider whether faunal assemblages other than fish middens exhibit temporal changes which could be related to the onset of commercial fishing. This might be expected if, as suggested in Section 7.5 below, fish middens (and perhaps commercial fishing) were only one facet of settlements with diverse economic foci. Some households might engage in the production of cured goods for exchange without creating semi-specialised activity areas such as Area A at Robert's Haven.

The possibility that the proportion of fish represented in Norse middens changed through time was investigated first. The results were not particularly informative. Inter-site differences in methodology make it meaningless to compare the relative proportion of mammal, bird and fish bone in many faunal assemblages from the earldoms (see Table 5.1 and Appendix 5.1). Moreover, for the 11 assemblages which can be broadly compared, most variability relates to recovery strategy and preservation. The relevant data are illustrated in Figure 5.23 (introduced in Chapter 5 above) in approximate chronological order. The most obvious pattern is the unsurprising observation that well sieved assemblages generally have more fish bone than poorly sieved or (in the case of the Brough of Birsay) poorly preserved assemblages (see Section 5.6). There is no evidence of a clear chronological pattern.

It is possible to circumvent some limitations of inter-class comparison by focusing exclusively on fish bone assemblages. Figure 5.24 illustrates the relative abundance of gadoid fishes (combined at the family level to avoid most of the discrepancies in identification methods noted in Table 5.1) *vis-à-vis* all other fish taxa for 16 Viking Age and Late Norse assemblages. If cod family fishes were the likely focus of export, as seems probable from both historical and archaeological evidence (see Sections 5.6 and 8.2), one might expect the onset of trade to be marked by a change in the relative abundance of this family. Such a change could take the form of an increase - assuming a more intense fishery - or a decrease - assuming that some bones were exported in the cured product (see Section 8.2). Contrary to these predictions, there is no clear chronological trend in the relative abundance of gadoid and other fishes. Cod and related taxa constitute over 90% of every assemblage for which the data are comparable, regardless of preservation and recovery factors.

To take this line of inquiry further, the relative proportion of different cod family fishes was also examined (Figure 5.25). If a narrow selection of taxa were considered marketable, as was the case in early modern Shetland (Fenton 1978:571), particular species might fluctuate in abundance at the onset of export trade. Once again, however, there is little clear evidence for a chronological trend. The proportion of cod is relatively low compared to saith in some Late Norse assemblages. It is conceivable that some bones from this taxon - a primary candidate for medieval cured fish production (see Section 8.2) - were being differentially removed with an export product (see Bigelow 1984:127-128 and Section 8.2). It is more likely, however, that the apparent abundance of cod in the Viking Age is a function of the relative representation of the smaller species saith. The latter taxon is probably underestimated in the Viking Age assemblages for which recovery methods were often less thorough (see Section 5.6 and Table 5.1).

It was also hoped that fish total length estimates (illustrated in Figures 5.26-5.50 and discussed in Section 5.6 below) might reveal chronological patterns suggestive of a focus on fish sizes thought suitable for exchange. Once again, however, the pattern is ambiguous. Bone measurements are only available for one Viking Age assemblage (Pool Phase 7) for which recovery was predominately by hand (Table 5.1). Moreover, the Late Norse assemblages all yield broadly similar size distributions. The implication of these distributions in terms of fishing strategy has been discussed above. They shed little light, however, on the date at which a putative fish trade might have began.

As a final attempt to isolate when fish trade may have begun the relative abundance of domestic mammal taxa was considered. Gerald Bigelow (1985; 1989) has suggested that changes in the pastoral economy may reflect contemporary shifts in the exploitation of marine resources. Specifically, he suggested that a shift towards intensive cattle dairying may have paralleled the development of an export fish trade (Bigelow 1989:189). Although the distribution of cattle, sheep or goats, pigs and horses shows some interesting idiosyncrasies (some of which have been discussed in Chapter 5), there is no definitive chronological pattern (see Figure 5.21). Cattle are more abundant at some Late Norse sites, but this interpretation is heavily influenced by Freswick Links where the relative proportion of large and small ungulates may be related, at least in part, to recovery of several articulated skeletons (see Section 5.5). The age at death evidence for intensive dairying, discussed in Section 5.5 and Appendix 5.7, is similarly ambiguous.

To conclude, there is no zooarchaeological evidence to suggest a change in fishing activity at any time from the Viking Age to the appearance of distinctive fish middens in the 13th and 14th centuries. Phase 8 at St. Boniface may push this date back into the 12th or even 11th century, but additional zooarchaeological data are necessary to establish whether it is truly comparable to deposits at Robert's Haven and Freswick Links. If the latter sites are associated with an export fish trade, it may have begun in the final years of the Late Norse Period. It is also possible, however, that earlier fish middens remain to be discovered.

7.5 What was the Settlement Context of Fish Middens?

Thus far this chapter has established the existence of fish middens in the earldoms, suggested that they are consistent with activity of commercial scale and observed that the known examples (Freswick Links and Robert's Haven) probably date to the 13th and 14th centuries. It is now worth turning explicit attention to the context in which they formed. Were they:

1) the residue of specialised (possibly seasonal) fishing stations,

2) the foci of fishing activity by many households within the regions or 'estates' of Duncansby and Freswick, or

3) fish processing activity areas within single permanent settlements?

In medieval Norway and post-medieval Shetland fishing was sometimes conducted from specialised stations occupied in only one season (Fenton 1978:576; Magnus 1974; Urbanczyk 1992:252). It is unlikely, however, that Robert's Haven and Freswick Links can be perceived in a similar light. The size distributions of small cod family fish is normal rather than polymodal (see Figures 5.26-5.28, 5.37-5.40). If fishing activity occurred in a single season fish age classes should be represented as distinct size groups (e.g. Mellars & Wilkinson 1980). Distributions of this sort do exist for single strata at both sites (Rackham forthcoming; see discussion of samples 1005 and 1006 in Section 7.3 above). However, these presumably represent short term events such as single fishing episodes rather than the sum of annual fishing activity.

The evidence against strictly seasonal activity holds only for young fish. Age classes become blurred in larger specimens as environmental factors affect growth. It is conceivable that large gadoid fish (which probably occupied deeper waters) were sought only during favourable seasons. If they were caught seasonally, however, it is necessary to envision a separate fishery for smaller fish which was prosecuted at various times throughout the year.

Some evidence regarding seasonality may also derive from soil micromorphology (Simpson & Barrett forthcoming). Textural and excremental pedofeatures in the fish midden at Robert's Haven suggest short term hiatuses in accumulation. Fine material was mobilised from exposed surfaces and some decomposition and reworking of the sediments occurred. The minimal scale of these features is consistent with a short term, possibly seasonal, cycle of deposition and non-deposition.

The conflicting evidence of fish size distributions and soil micromorphology can be reconciled in two possible ways. First, it is possible that the periodicity evident from the soil thin sections simply represents random or systematic movement of the focus of deposition over the midden surface. Second, fishing may have occurred at *several* distinct times throughout the year. This pattern could create both a hiatus in deposition and a relatively normal distribution of fish length estimates. Theoretically, study of incremental growth patterns in otoliths could help resolve these uncertainties (e.g. Enghoff 1994:78-81). It was not attempted in the current study, however, due to Jones' (1991a:287-293) unsatisfactory results from Freswick Links. Similarly preserved otoliths from Robert's Haven are unlikely to yield better results.

Having suggested that Freswick Links and Robert's Haven were not seasonal settlements, it remains to consider whether they represent permanent occupation or simply regular fishing activity. The former interpretation is by far the more likely. At both Robert's Haven and Freswick Links ecofactual, artifactual and structural evidence are all suggestive of permanent occupation and diverse farmstead activities.

The ecofactual evidence from Robert's Haven is summarised in Figures 7.29-7.39. While fish bone dominates Area A - the fish midden - mammal bone, bird bone, burnt peat and carbonised cereal grain were also ubiquitous. Mineralised casts of monocotyledon leaves (perhaps of grasses or sedges) were also found in Area A (Huntley pers comm.). Soil thin section evidence adds peat, peat ash and possibly herbivore dung to this list (Simpson & Barrett 1993). All of these inclusions suggest the existence of adjacent settlement. The subsistence implications of bone and cereal grain are somewhat self-evident. Peat remains a common household fuel in treeless parts of Northern Scotland (Fenton 1978:210-213). Unburned turf and dung could have entered the middens together as the former has been used as animal bedding in Orkney in early modern times (Fenton 1978:281; see also Simpson 1993). The monocotyledon leaves, possibly animal bedding or fodder, may also have derived from byres. They could, however, have grown naturally on the midden surface.

Approximately 1133 fragments of pottery were also recovered from Area A. Most of these were of local chaff or dung tempered coarse ware (Jones 1995; Ross 1994) which could conceivably have been used for rendering fish oil (see McGregor 1880:145-146). However, three sherds of imported wheel made pottery (Will 1995) may be more consistent with relatively high status domestic settlement (see Chapter 9). A tinned copper spoon found in Area A probably supports this interpretation (Figure 7.41). As suggested in Section 7.3.3 above, much of this material probably derives from domestic rubbish dumped on fresh fish processing waste - possibly to reduce odour or control scavengers. Some waste from local fish consumption also entered the midden in this way (see Section 8.3.5). In summation, Area A is not *exclusively* a fish processing dump, but rather a semi-specialised deposit.

Much of the settlement from which this rubbish came has presumably been removed by past sand quarrying at Robert's Haven (see Section 5.3.2). However, some contemporary deposits survive in Areas B and E. The probable Late Norse strata of Area B have low concentrations of cultural inclusions. Soil micromorphology indicates that they are composed primarily of peat ash and wind blown sand (Simpson & Barrett forthcoming). Nevertheless, these strata also include shell (some of which, however, is comminuted and probably natural) and trace levels of fish bone, mammal bone, bird bone, burnt peat, carbonised cereal grain and pottery. Shell and mammal bone dominate Area E, but background levels of fish bone, bird bone, burnt peat and pottery were also recovered. Carbonised botanical material from this area has not yet been analysed.

Examining the ecofactual evidence in more detail, the presence of neonatal cattle bones (Mainland pers comm.) - coupled with the possible indication of herbivore dung mentioned above - could suggest on site pastoralism. Moreover, cereal chaff (including 49 barley rachis internodes, 28 oat floret bases and 33 straw culmn nodes) and weeds of arable crops (such as 168 corn spurrey, *Spergula arvensis*, and 1336 chickweed, *Stellaria media*, seeds) are among the carbonised plant remains from Area A (Huntley & White pers comm.; see Table 5.8). This evidence is typically used to support local cereal cultivation (e.g. Hillman 1984) and the ratio of chaff to cereal grain is actually greater than at the more definitive settlement site of Earl's Bu. For example, the ratio of barley rachis internodes to grains is 5.2:100 (49:947) at Robert's Haven Area A and 1.3:100 (8:613) at Earl's Bu. The recovery of a tiny quantity of wheat (which is not grown in the current environment of Caithness [Coppock 1976]) at Robert's Haven could suggest some importation of cereal (see Section 5.4). It would seem, however, that at least barley and oats were probably grown and processed by the inhabitants of an adjacent or nearby settlement.

Structural evidence is slightly ambiguous. Walling in Area B at Robert's Haven post-dates the Late Norse Period and the building in Area E has not been excavated (see Section 5.3.2). Nevertheless, nearby settlement is suggested by record of a medieval chapel (Royal Commission on the Ancient and Historical Monuments of Scotland records; see Figure 5.4). It is also relevant that the site lies within the estate of Duncansby - an island of agricultural land in a sea of blanket peat (Macaulay Institute for Soil Research 1982a; 1983a) - which appears in 17th to 19th century records (e.g. Grant 1902:3; Matheson 1817). It is included in Blaeu's 17th century *Atlas Novus* (Stone 1991:37), but the earliest detailed depiction is from the 18th century *Military Survey of Scotland* (Plate 2.1). There is little reason to doubt that this estate can be equated with a farm of the same name associated with the 12th century magnate Sveinn Ásleifarson in *Orkneyinga Saga* (Pálsson & Edwards 1981:101, 124, 145, 150-151; see Waugh 1986:101-102).

In summation, Robert's Haven may have been a permanently occupied settlement with diverse economic foci: principally pastoralism, arable agriculture and fishing. The fish processing midden of Area A can be perceived as one activity area within this settlement.

A similar interpretation can be offered for Freswick Links. As at Robert's Haven, a chapel of presumed Late Norse date is recorded in the immediate vicinity of the archaeological evidence (Batey 1984:63; Withrington & Grant 1979[1791-1799]:23). Moreover, structural remains in the Middle Cliff Areas (broadly dated to the Late

Norse Period) could represent dwellings (Rains & Morris forthcoming). It is in this section of the site that mammal bone is most abundant, creating a pattern not unlike that found at Robert's Haven. Presumed dwellings of Late Norse date, complete with hearths, have also been investigated in Area 2 (Batey 1987a:69-100). However, final publication of results from this area are still forthcoming. The Late Norse faunal evidence from Freswick Links includes neonatal and articulated cattle bones, perhaps suggesting local pastoralism (Gidney forthcoming).

Botanical evidence from Freswick Links is more complicated. As discussed in Section 5.3.3 above, radiocarbon assays on carbonised cereal grain yielded earlier (Pictish) dates than was indicated by artifactual analysis, thermoluminescence dates on pottery and ^{14}C assays on bone (see Figures 5.13-5.15). The most straightforward explanation for this may be the redeposition of earlier material on Late Norse middens (Morris et al. forthcoming b). By analogy with Robert's Haven, this process may have been intended to reduce odour and dissuade scavengers associated with fish processing waste.

Regardless of the precise mechanism of mixing, the dating evidence implies that botanical remains cannot be interpreted exclusively in terms of Late Norse economic patterns. They presumably represent a mixture of pre-Norse and Norse activity. The implications for bone may not be so severe. Articulated fish and mammal remains (Gidney forthcoming; Jones pers comm.), combined with the radiocarbon results from bone (Morris & Cook forthcoming), suggest that much of this material is in a primary context.

To digress momentarily, the early date of cereal from Late Norse contexts at Freswick Links provides a cautionary tale of potential relevance to Robert's Haven. Is it possible that the household rubbish dumped in Area A was not contemporary with the fish bone? This is conceivable, but seems unlikely given the correspondence between artifactual and radiocarbon dating evidence. It is unlikely that the pottery was introduced with residual cereal grain as it included both largely complete collapsed vessels and small sherds.

Leaving the issue of residuality aside for the moment, it is necessary to address arguments raised under the assumption that at least some botanical macrofossils from NCA and MCA at Freswick Links were Late Norse in origin. Huntley and Turner (forthcoming) suggest that the relative paucity of cereal chaff and seeds of arable weeds could imply that grain was imported to the site rather than grown and processed locally. The disappearance of barley-type pollen from a peat core at the nearby Hill of Harley (at the onset of the Viking Age) provides some support for this argument

(Huntley 1994; forthcoming). Moreover, the presence of small quantities of wheat at Freswick Links is cited as further evidence for the importation of cereals (Huntley & Turner forthcoming).

The possibility of grain import is an interesting hypothesis well worth considering. The presence of wheat at the site may be particularly suggestive. However, each tenet of this argument is disputable. As Huntley and Turner (forthcoming) acknowledge, it is not a forgone conclusion that the wheat at Freswick Links was imported. This crop was grown as far north as Dunrobin (Golspie), Sutherland, in the 18th century (Pennant 1979[1774]:170), and could conceivably have been tried further north prior to the deleterious environmental impact of the Little Ice Age (Grove 1988; see Section 2.6). Wheat might also occur in small quantities as an incidental component of other cereal crops (Huntley & Turner forthcoming). Furthermore, the recovery of five wheat rachis internodes may suggest local processing (given that only 28 wheat grains were recovered). It would be unwise, however, to attach too much significance to such a tiny sample.

Huntley and Turner also note that the disappearance of barley-type pollen from the Hill of Harley peat core could represent very local movement of field locations. Cereals are essentially self-pollinating and will not contribute to the palynological record more than a few hundred metres away (Huntley 1994:539). Cereal chaff and seeds of arable weeds *are* rare, particularly in NCA (see Table 5.8). However, they are more common in MCA and their relative paucity could relate to the sorting strategy used for the Freswick Links botanical samples. Cereal grain was collected from all flotation samples while other botanical macrofossils were only systematically sorted from a 10% random sub-sample (Huntley & Turner forthcoming).

A final argument against local arable agriculture at Freswick Links was the assumption, based on the current barren landscape of the bay, that "the area available for cereal cultivation would have been limited, given the nature of the terrain behind the links" (Morris et al. forthcoming b). However, the 18th century *Military Survey of Scotland* indicates that Freswick, like Duncansby, was in fact a focus of agriculture prior to modern land use changes (see Plate 2.1). It may also be relevant that soils derived from wind blown sand - on which the site lies - were actually favoured for agriculture in 15th-16th century Orkney (Davidson et al. 1983:39). Furthermore, *Orkneyinga Saga* implies that Freswick supported a substantial farming community in the 12th century (Pálsson & Edwards 1981:185, 189, 194).

The available evidence is consistent with the existence of a permanent settlement at Freswick. As at Robert's Haven, the inhabitants presumably engaged in a variety of economic activities. These included, but were not limited to, catching large quantities of fish which were processed at particular activity areas (primarily in NCA and some strata of MCA and Area 9).

Methodological inconsistencies have prevented confirmation that other deposits in the earldom's are comparable to fish middens at Robert's Haven and Freswick Links. Nevertheless, it is worth considering the context of the three sites which have been qualitatively described in similar terms: Quoygrew, Sandwick and St. Boniface. Each is on good agricultural land (Macaulay Institute for Soil Research 1983a; 1983b) in the immediate (St. Boniface) or general (Quoygrew, Sandwick) vicinity of a chapel (Bigelow 1985:97, 99; Cant 1984; Lowe 1993:19-21). Moreover, they have all yielded possible domestic rubbish such as carbonised vegetation, mammal bone, bird bone and - excluding St. Boniface - artifacts such as worked bone and pottery (Bigelow 1985; Cerón-Carrasco forthcoming; Colley 1983a:208-212; Hamilton-Dyer forthcoming; Lowe 1993:30-31; McCormick forthcoming). In the case of St. Boniface and Sandwick, the sites for which mammal bones have been analysed, the presence of neonatal cattle may indicate local pastoralism (Bigelow 1984:133-134; 1989:188; 1992:19; McCormick forthcoming). St. Boniface also yielded neonatal sheep remains (McCormick forthcoming). Moreover, deposits rich in fish bone at Sandwick are directly associated with a dwelling and possible structural remains were identified at Quoygrew (Bigelow 1985; Colley 1983a:209). If 'fish middens' did exist at these sites, they too represent activity areas in settlements with diverse economic interests.

7.6 Discussion

Distinct 13th-14th century deposits dominated by fish bone and shell (the latter possibly representing bait) do exist at Robert's Haven and Freswick Links. These can be contrasted with domestic rubbish dumps characterised by a larger proportion of mammal bone. The latter exist as separate deposits in the archaeological landscapes of Robert's Haven and Freswick Links. They are also evident at other settlements such as Earl's Bu in Orkney. Preliminary consideration of site formation processes within Freswick Links and Robert's Haven - and comparison of fish assemblages from Robert's Haven and Earl's Bu - suggests that this difference is behavioural rather than taphonomic in origin.

The scale of fish middens identified at Freswick Links and Robert's Haven may be consistent with commercial rather than domestic activity. A heuristic model based on Area A (the fish midden) at Robert's Haven suggests that 10000-100000 fish a year could have been processed. This figure is not considered accurate, but may reflect the order of magnitude of local fishing activity. Assuming a pattern of trade similar to post-medieval Shetland - in which fish cured throughout the year were traded annually by a cross-section of the local population - the middens at Robert's Haven and Freswick Links are probably consistent with cured fish production for export. One of the largest commercial fishing stations in 18th century Shetland was responsible for the catch of only 50000 fish per year (Fenton 1978:573).

Inter-site differences in methods of ecofact recovery and analysis make it difficult to isolate other possible fish middens in the earldoms. Qualitative descriptions of deposits at three sites - Quoygrew, Sandwick and St. Boniface - are all suggestive. However, their similarity to Robert's Haven and Freswick Links cannot be confirmed quantitatively. It is thus impossible to suggest whether fish middens occur in the earldoms prior to the two definite 13th-14th century examples. The identification and dating of similar deposits is therefore an important avenue for future research.

Finally, evidence from Robert's Haven and Freswick Links (and tentatively Quoygrew, Sandwick and St. Boniface) suggests that fish middens were semi-specialised activity areas within permanent settlements with diverse economic foci. They probably do not represent seasonal stations or the year-round fishing harbours of distant settlements.

Chapter 8

Robert's Haven and Earl's Bu: Assessing the evidence for cured fish production

8.1 Introduction

To this point, four circumstantial arguments have been offered for the existence of a cured fish trade in the Late Norse earldoms. First, archaeological and historical evidence for local participation in long distance trade was explored (Section 6.8). Second, historical evidence for the participation of other regions of Scandinavia and Scotland in the export of dried fish was illustrated (Section 6.9.2). Third, limited medieval and plentiful post-medieval historical evidence for fish export from Orkney, Caithness and Shetland was considered (Sections 6.9.3 and 6.9.4). Last, the existence of a distinct class of archaeological deposit, the (gadoid) fish midden, was demonstrated on two (and possibly more) Late Norse sites dating to the 13th-14th centuries. As discussed in Chapter 7, the *scale* of fish middens may be consistent with an export trade. It remains to consider, however, whether the *fish products* made at these sites are consistent with such a trade.

In the current chapter, this issue is explored in considerable depth. The focus is on Robert's Haven, a site investigated by the author specifically to elucidate the character of Late Norse fish processing. The site was introduced, and compared to other Norse deposits in the earldoms, in Chapters 5 and 7. In this chapter, the faunal evidence is studied in order to identify or discount the production here of cured fish products known to have been traded in the Middle Ages. Zooarchaeological data are compared to a model of cured fish processing developed from a variety of ethnohistoric and archaeological sources. In Section 8.5, they are also contrasted with results from a broadly contemporary domestic midden at Earl's Bu, Orkney. In conclusion, evidence from other fish bone assemblages in the earldoms - introduced in Chapter 1 - is briefly reassessed in light of findings from Robert's Haven and Earl's Bu.

8.2 Establishing a Model for Recognising Cured Fish Production

8.2.1 Introduction

As discussed in Chapter 1, several studies have attempted to use the relative distribution of fish bone elements as evidence for or against the production (and possible export) of cured gadoid fish (e.g. Bigelow 1984:126-129; Cerón-Carrasco 1994:209-210; forthcoming, Colley 1984:127; 1989:255; Jones et al. forthcoming b; Nicholson n.d.b:30). In all of these studies, the distribution of elements is compared to a vaguely defined model of cured fish production. It is assumed that heads were removed, remaining at the processing site, while vertebrae and appendicular elements such as the cleithra were left in an exported product. This model derives from a mixture of inductive reasoning - based on the fish bone distributions themselves (even when the evidence is ambiguous as at Quoygrew and Tuquoy, see Section 1.3.3) - and passing reference to modern or recent methods of fish curing (e.g. Cerón-Carrasco 1994:210, Colley 1983c:113; 1984:127 Jones et al. forthcoming b). The notion of decapitation also has an ultimate basis in fish anatomy, and has been used to interpret faunal evidence from archaeological contexts as diverse as New Zealand (Shawcross 1972) and the northwest coast of North America (Butler 1993). Although this model is useful in broad outline, it can be better understood by explicit study of the ways in which gadoid fish have been cured in the past and present.

8.2.2 Possible Methods of Fish Curing: A brief overview

Prior to the 19th century introduction of railways in the north of Scotland, all fish had to be shipped to distant buyers by sea (Ross 1883:106-107). Thus, short term preservation methods such as packing in straw (Cutting 1955:44) could only have been used for transport to relatively local consumers. The preservation of fish for *export* from the earldoms could therefore have been effected in one (or a combination) of nine ways. They could be cooled, frozen, sterilised, acidified, sugared, kept alive in water filled compartments, smoked, salted or dried (Coull 1972:80; Hörandner 1986:53).

Cooling and freezing are unlikely to have played a role in the relatively ice free conditions of northern Scotland (e.g. Davidson & Jones 1985:18-19). Sterilisation is equally unlikely, as its use is principally associated with the 19th century development of canning (Hörandner 1986:56-57). Acidification and sugaring are technically possible, but have not been recorded as historical method for the large scale preservation of cod family fish (Cutting 1955; Walker 1982). It seems likely, moreover, that these methods would have been prohibitively expensive for the preservation of taxa which were used as a utilitarian food for a variety of social classes (see Hammond 1993:10-11, 32, 47, 63; Prestwich 1967). The use of well boats (vessels with water filled compartments) to transport live fish in northwestern Europe is recorded predominately from the 17th century and later (Coull 1972:80; Cutting 1955:204). Moreover, the export of live fish would be archaeologically invisible and need not be considered in the context of fish bone middens.

Given these caveats, the possible methods of preserving fish in the Norse earldoms has been reduced to smoking, salting, drying or some combination of the above. The smoking of fish, with or without prior salting, is known from early modern Scotland (e.g. Ross 1883:111-121) and post-medieval Scandinavia (e.g. Magnus 1555:722) - the simplest method being suspension above a household hearth (Fenton 1978:529). Smoked herring were being marketed in 14th century England and it seems likely that they were sufficiently well cured to permit transportation over considerable distances (Cutting 1955:71). Herring, fatty fish, will turn rancid within 24 hours if not cured, but keep well once smoked or pickled (Hörandner 1986:55; Ross 1883:123-124). One variety of smoked herring produced in 19th century Scotland would "keep good a year" (Ross 1883:124).

Conversely, smoked cod family fishes usually do not keep particularly well. Ross' (1883:111-121) account of Scottish smoking practices in the 19th century describes a variety of methods, many of which produced cures which might last for only a few days or a week in the summer season during which Late Norse navigation occurred (e.g. Dasent 1894b:365). Longer lasting cures were possible, particularly in winter months (Ross 1883:111-121). It seems unlikely, however, that smoked gadids could be a reliable export commodity in a polity so far removed from the primary consumers of Scandinavian fish exports (England and continental Europe, see Urbanczyk 1992:133-145).

Fish can be salted by pickling in brine or by impregnation with salt prior to smoking or drying. The preservation of fish, particularly herring, in brine filled barrels is explicitly recorded by the 14th century and can probably be assumed earlier (Coull 1972:72-73). Herring shipped from Inverness in 1266 (Stevensen 1988:186) were probably cured in this way, although smoking cannot be entirely ruled out. Salmon were pickled in 16th century Sutherland (Murray 1993) and it seems probable that 14th century accounts of its export from Scotland (Ewan 1990:91) imply a similar procedure.

Cod family fish have also been cured in this way, particularly after European discovery of the rich fishing grounds of the new world (e.g. Faulkner 1985:59). Fish could be cured on board ship without the need to establish drying facilities on foreign shores. If desired, the resulting product could be dried later on return to Europe (Vollan 1959:344). However, this method is not known from medieval Scandinavia. Cutting (1955:122), for example, suggests that it was not adopted in Norway until the end of the 15th century.

The antiquity of salting and drying (or simply drying) cod family fish in the Scandinavian North Atlantic is not in question. Dried fish appear in 12th century accounts (e.g. Christensen 1985:255; Sephton 1899:129) and are commonplace in 13th and 14th century records (e.g. Magnusson & Pálsson 1960:56, 58; Pálsson & Edwards

1989:135-139; Vollan 1959:343-344; see Urbanczyk 1992:133-145). Two distinct products can be identified. The first is fish air dried without salt, referred to as stockfish from the middle ages (e.g. Brereton & Ferrier 1981:237; Prestwich 1967:541, 543; Querini in Bertelsen 1985b:207) to the present. The second is fish which are both salted and dried. It has been referred to by a number of different names, some geographical or chronological, others based on distinctions of size, quality or taxonomy. Examples include bacalao (Spanish for cod), haberdine, poor john, old ling, ling, lob, orgeys and klipfisk (Cutting 1955:26, 32, 36, 119-120, 142; Innis 1954:11; Vollan 1959:344). It is tempting to adopt the Scandinavian term klipfisk in this study. It will be avoided in favour of "dry salt fish", however, to prevent the danger of chronological confusion. Narrowly defined, klipfisk has been perceived as a product first made in Norway in the 17th century (Coull 1972:80; Vollan 1959:344). As will become clear below, however, it is possible that similar products were being made in the earldoms several centuries earlier.

8.2.3 Some Current and Early Modern Production Methods

The above review suggests that drying, or salting and drying, are the most likely methods of curing gadoid fish in medieval Scandinavian settlements of the North Atlantic. How precisely, however, are fish butchered in order to effect these cures? In order to construct a model of stockfish or dry salt fish production I begin with a brief survey of some current and recent processing methods in Norway and northern Scotland. Medieval and post-medieval evidence is considered below in Section 8.2.4. Figure 1.3 illustrates a cod skeleton with which the following discussions can be compared.

A useful starting point was provided by the quality regulations relating to stockfish and klipfisk published by the Fiskerinæringens Landsforening (Federation of Norwegian Fishing Industry). Stockfish (Fiskerinæringens Landsforening n.d.:77-82) may be produced with the head removed or left on. If removed, fish heads may be dried for animal fodder or for human consumption (with the gills removed in the latter case). Fish may be prepared as "split fish" (*rotskjaer*) with the backbone removed "to three joints behind the vent" or as "round fish" with all vertebrae posterior to the cleithra ("ear-bones") left in-situ. The wording of the document implies that the cleithra are also left in situ. Plate 8.1 illustrates a contemporary stockfish (kindly provided by A. Jones), showing in detail the presence of the cleithra and removal of anterior vertebrae. Plate 8.2, shows round fish, split fish and fish heads drying at Stø, Andoya, Norway (courtesy of P. Buckland).

Contemporary processing of klipfisk (dry salt fish) in Norway is equally variable. The Fiskerinæringens Landsforening (n.d.:59-73) regulations imply that fish heads are always removed, but treatment of the post-cranial skeleton varies considerably. All or only the anterior two thirds of the vertebral column can be removed. Conversely, (in the case of small saith) the entire vertebral column can be split lengthwise and left in the fish. The cleithra and all other elements associated with fins can be left in the finished product or removed. Plate 8.3 illustrates klipfisk (Orcadian in this case) in which the cleithra have been removed but some caudal vertebrae are left in situ.

In summation, contemporary Norwegian processing methods could leave widely variable zooarchaeological patterns at a processing site: no bones, all bones, skull bones only, appendicular bones only, anterior (or all) vertebrae only, or any combination of the above. Typically, however, at least appendicular elements and posterior caudal vertebrae would be removed from a production centre as part of cured stockfish or klipfisk.

In northern Scotland, fish shops in Stromness and Kirkwall, Orkney, were visited to collect specimens and information on local fish curing methods. This information was supplemented by two interviews with elderly fishermen in Lerwick, Shetland, by the examination of photographs from the turn of the 19th century, and by study of primary historical descriptions of fish processing from 18th and 19th century Orkney and Shetland. Information from these archipelagos was preferred to potential data from Caithness due to radical changes in the fishing traditions of the latter brought about by the late 18th and 19th century herring boom (see Gray 1978:27-38).

Of the specimens purchased in Kirkwall and Stromness, the former were cured by the seller (William Jolley Fishmonger) while the latter had been imported from Shetland. The examples from Kirkwall were dry salt specimens analogous to Norwegian klipfisk. They were manufactured from cod, saith and torsk using similar processing methods in each case. Skulls, appendicular elements, abdominal vertebrae and some anterior caudal vertebrae were removed - but posterior caudal vertebrae remained in situ (Plate 8.3). The specimens from Stromness included dry salt saith, whiting and ling. The saith (Plate 8.4) were gutted but not split, with all except the most anterior vertebrae left in situ. The heads had been removed posterior to the cleithra, leaving only portions of the ventral fins, including a basipterygium, attached to the cured product. Dried whiting (Plate 8.5) were also un-split with the vertebrae left in situ. The cleithra and associated appendicular bones had been cut through during decapitation, leaving posterior portions in situ. Dry salt ling (Plate 8.6) contained no bones at all, with the exception of a few unidentifiable ribs and vertebral fragments. If this last product was made in the Viking Age or Late Norse Period, it would leave no observable signature in the zooarchaeological record.

These examples clearly illustrate that similar fish can be processed in different ways - an observation further illuminated by interviews in Lerwick, Shetland. Two small whiting drying in James Wishart's kitchen window had been decapitated posterior to the appendicular skeleton (unlike those purchased in Stromness). Conversely, William Leask (who fished from a modified sixareen* between the first and second world wars) carefully explained that he had always removed the heads of gadoid fishes *anterior* to the cleithra.

Early 20th century processing methods can also be illustrated with photographs taken c.1900 at Kirkwall, Orkney, by Tom Kent (Plates 8.7 and 8.8). Cod were decapitated anterior to the appendicular skeleton, leaving cleithra and fins in the cured product. The fish were also split open for most of their length, suggesting that some anterior vertebrae had been removed.

The variability in modern fish processing methods observed in Norwegian sources is evidently matched in Orkney and Shetland. This cursory survey has identified butchery strategies which could leave *all fish bones* or *only skull bones and some combination of appendicular and vertebral elements* at a processing midden.

This inconsistency is not entirely a 20th century innovation. An account of fish processing in 18th century Shetland by George Low (1879[1774]:120-121, 137, 187) describes three methods. His most lengthy description refers to a dry salt product like those photographed by Kent over 100 years later:

> Immediately as the boats come on shore, and the fish are numbered, the splitters, washers, and salters, set to work upon them; the first, with a stroke or two of a large knife, cuts them open from the neck to the tail, pulls out half the bone [Contrast with a later reference (Low 1879[1774]:187) implies that heads were also removed], and throws the fish to the washer, who immediately washes them in the sea, and after they have drained, a pretty thick layer of salt is thrown on the bottom of a large chest (caulked and pitched for the purpose), a layer of fish is laid in order so as to contain well, then a layer of salt, and so stratum super stratum till the chest is full. They commonly salt twice a week, Monday and Wednesday, but this depends much on the quantity got. They are dried on a beach; and where they have not this conveniency naturally, they force it by covering the green with stones. In clear weather, a little time drys fish, but gloomy, misty, or wet weather (and such is too common in Schetland), renders them brown, and spoils them. A well cured fish is a fine greenish colour, and when held between the eye and the light looks transparent (Low 1879[1774]:120-121).

* An open decked sailing and rowing boat (see Morrison 1978:58).

This description (and other, sometimes derivative, accounts from the 18th century to the present, e.g. Hibbert 1822:519; Ross 1883:126; Walker 1982:141) and photographs such as Kent's, form the current popular image of cured fish in Orkney and Shetland. It is manifest, for example, as plastic models in the Böd of Gremista, Lerwick, a museum in the overseers office of an 18th century fish-curing yard (Gifford 1992:494).

Low's other descriptions of fish curing have attracted less attention. He explains that in Hamna Voe:

> The fish are split in a different manner here from the rest of Schetland, only the three upper joints of the back-bone are cut out, being designed for the Irish market, whereas, elsewhere they pull out one half (Low 1879[1774]:137).

Moreover,

> round sumburgh head, especially where the tides are quick, is a large fishing of Seathfish (the Coalfish; Br. Zool. 152) [saith, *Pollachius virens*], which are here caught in great plenty, and cured with the heads on, like Scoth cured Keeling. These are generally sold at a Scottish market ... (Low 1879[1774]:187).

The last method would be archaeologically unrecognisable, as it leaves no bones for disposal at a processing site. Conversely, the first two procedures might leave skull bones and some abdominal vertebrae behind. The one consistent feature of all three methods is that some bones always remained in the cured product.

This brief survey of current and early-modern fish processing methods in Norway, Orkney and Shetland is far from comprehensive. Nevertheless, it provides two useful lessons. The first is the unreliability of too rigid a model of cured fish production. Inter- and intra-regional variation is to be expected. The second is the necessity of using analogs with some spatial and temporal connection to the archaeological context in question. Fish curing methods are evidently culturally dependent patterns which can change through time and space. Many bones remained in all of the products described by Low and subsequent 18th and 19th century commentators. Conversely, some of the fish collected in Orkney during fieldwork for this thesis were cured with most or all bones removed - perhaps to suit the expectations of 20th century British consumers. The ling from Shetland pictured in Plate 8.6 provides an excellent example.

8.2.4 Medieval and Post-medieval Evidence: Establishing a flexible model of cured fish production

With these observations in mind, it is of value to turn to medieval and post-medieval evidence (historical, pictorial and archaeological) regarding fish processing which may have some connection with the Scandinavian north. The earliest evidence which can be directly associated with the Norse earldoms comes from *Orkneyinga Saga*. It includes the mention of Uni, who "stayed at home looking after the catch" in Fair Isle while his 'adopted' sons were fishing (Pálsson & Edwards 1981:132). While this reference implies that fish were processed it provides no detail regarding curing methods.

In *Eyrbyggja Saga*, set and written in Iceland (probably in the mid 13th century), only skins are left after a ghost consumes the household supply of dried fish (Pálsson & Edwards 1989:139). While also lacking in detail, this account implies that some bones of the appendicular skeleton (which are associated with the pectoral and ventral fins) might remain in the dried product.

The best medieval description of stockfish (possibly exported from the Scandinavian North Atlantic) derives from a French household management book of c.1393 known as *Le Menagier de Paris* or *The Goodman of Paris* (Brereton & Ferrier 1981; Power 1928). It explains that cod,

> when it is taken in the far seas and it is desired to keep it for ten or twelve years, it is gutted and *its head removed* and it is dried in the air and sun and in no wise by fire, or smoked, and when this is done it is called stockfish. And when it hath been kept a long time and it is desired to eat it, it behoves to beat it with a wooden hammer for a full hour, and then set it to soak in warm water for a full hour, and then set it to soak in warm water for a full two hours or more, then cook and scour it very well like beef, then eat it with mustard or soaked in butter. And any remain in the evening, let it be fried in small pieces like shreds and spice powder thereon (Power 1928:272-273; emphasis mine).

The Exchequer Rolls of Scotland for the year 1329 (Stuart & Burnett 1878:239, see Section 6.9.3) record that 15000 hard fish, *durorum piscium*, were purchased from Symon, falconer of Caithness. While this description does not indicate the precise character of fish curing in the northern earldoms it does suggest that they were dried - either as stockfish or salt dry fish. The latter is perhaps more likely given a record from 1368 in which c.3500 litres of salt had been shipped to Caithness (Burnett 1878:308; see discussion in Section 6.9.3 below).

Two English cookbooks, of c.1420 and c.1450, also mention stockfish, including instructions to remove the skin prior to making "Balloke Brothe" (Austin 1888:10, 89-90). As in the *Eyrbyggja Saga* account, there is some possibility that appendicular bones associated with fins would remain attached to the skin.

An Italian merchant, Pietro Querini (in Bertelsen 1985b:207), wrote an account of his stay on the island of Røst, northern Norway, after a shipwreck in 1432. He explained that fish were dried by hanging in the wind without salt until they were as hard as wood, but provides no further detail regarding the preparation of stockfish.

Another late medieval reference to fish curing of immediate relevance is a Hanseatic edict of 1494 (Schäfer 1888:285). It is uncertain to what degree this description can be applied to the period prior to the start of direct Hanseatic trade with Shetland c.1416 (Friedland 1973; 1983:88). Nevertheless, it is one of few early records referring directly to the study area. The edict states that

> de Bergerfarer sollen ok nicht menghen Hithlander vysch mangkt den Bergerfisch, schollen ok mit ernste darvor wesen, dat de Hithlander visch moge gevlaket werden unnd nicht runt vor rothscher vorkofft (Schäfer 1888:285).

which might translate loosely as:

> The Bergen travelers also shall not mix Shetland fish with Bergen fish, but are to be careful that the Shetland fish should be 'gevlaket'and not sold round as 'rothscher'(I thank Sigrid Morrison and Dirk Heinrich for assistance with this translation).

The keys to interpreting this passage are the words *gevlacket* and *rothscher*. The scholar of Hanseatic history, Klaus Friedland (1983:94) translates Gevlacket as "opened, spread out and dried on the rocks", a description reminiscent of the salt dried product described by Low (1879[1774]:120-121) in 1774 and illustrated in Plates 8.7 and 8.8 from the turn of the 20th century. *Rothscher* probably refers to one variety of wind dried stockfish (Friedland 1983:94; Heinrich pers comm.). Dirk Heinrich (pers comm.) suggests that it implies a decapitated fish.

Post-medieval evidence is slightly more explicit. A reference to Icelandic stockfish from 1563 includes the information that they "plucke out the bones", presumably referring to some portion of the vertebral column (Cutting 1955:122). In 1545 the goods on the ship Jayms of Sir Thomas Darssys sent to the Iceland fishery included "guttyng", "splyttyng" and "heyddyng" knives (Þorsteinsson 1969:99).

An agreement of 1594 between Patrick Stewart, Earl of Orkney, and fishermen from the Scottish east coast burghs of Crail, Anstruther and Pittenweem provides a picture of the facilities necessary for fish curing (Johnston & Johnston 1907-1913:215-219). It stops short, however, of a detailed description of fish butchering.

> Patrik ... grantis full licence, libertie, fredome, facultie and power to the inhabitants and indwellares of the saidis townes ... that sall happin to fische within the saidis cuntreyis of Orknay and Zeitland induring all the tymes heireftir that they and ilkane of thame, with thair boittis and fischeares, may frielie hant and repair within the saidis cuntreyis or ony pairt thairof ... and use thair traffick of fisching within the same, *big fischearis housses, skewhowsses and utheris neidfull housses for making, paiking, drying and wynning of fische* that they sall happin to slay, and to win and to mak thair ulie, and lay thair boittis upon grund ...
>
> The inhabitants of the saidis townes ... sall pay to the said nobill lord yeirlie the dueteis eftir specifeit, that is to say, ilk greit ling boitt with thair land lyar, quhilkis twa boitis joint in ane sall pay yeirlie at the fisching of thair greit lingis for thair teind ane halff hundreth ling merchand wair and merchand pay, *and for thair grund leve within the fluid mark to dry thair fische* yeirlie ane barrell of small Scottis salt, ...
>
> ... and siclyke ilk boitt that sall happin to cum within the said cuntrey to the keiling handillingis allanerlie with thair land lyer sall pay for ilk boitt that sall haunt the said fisching as the utheris yeirlie ane hundreth keiling merchand wair *and pay, with ane barrell of small Scottis salt for thair licence to dry thair fische within the said fluid mark*, with twa dossane of keilling for thair land leve, allanerlie, for all uther thingis that may be askit or cravit of thame or thair successouris in tyme cuming (Johnston & Johnston 1907-1913:217-219, emphasis mine).

This account is interesting insofar as it indicates that fish were dried on the beach (presumably after salting), not hung as stockfish are.

Other evidence regarding 16th and 17th century Shetland and Orkney suggests that fish could be both air dried (producing stockfish) and dry salted. For example, Dionyse Settle (in Walker 1982:139) noted fish which were simply cut open and hung to dry during a visit to Orkney in 1577. An early 18th century account by Robert Sibbald (based on a description of Orkney and Shetland written by Robert Monteith of Egilsay and Gairsay, in 1633) includes the following information:

> The fishes they take for their own use, some of them they eat fresh, some they hang in skees [also "skeos", stone huts for drying meat and fish (Walker 1982:139)] till they be soure, and these they call blowen fish ... such as they design for merchant ware, some they salt and some they hang fresh in skees till they be perfectly dry, and they call those stock fishes, whereof they have great plenty (Sibbald 1845[1711]:17-18).

The account goes on to say that stockfish was only made in some locations, such as Fair Isle (e.g. Sibbald 1845[1711]:47, 52). Brewster (1830 in Walker 1982:139) later described a similar procedure elsewhere in Scotland - fish were hung to dry in caves.

The *Atlas or a Geographicke Description of the World* of Mercator, Hondius and Janssonius from 1636 is slightly more ambiguous. It includes a description of Shetland suggesting that

> the fish which they take, they partly salt and partly drie them: from the sale thereof they get mony to pay their tribute withall, and to fournish them their dwelling, houshold stoffe and a great part of their living (Theatrum Orbis Terrarum 1968:76).

It is difficult to tell if this account refers only to salt dried fish, or also to stockfish. Moreover, it is difficult to assess the degree to which it reflects local knowledge.

The production of stockfish, which could be done outside in the colder and (therefore) drier winter weather of Arctic Norway (Coull 1972:78; compare Davidson & Jones 1985:Table 2.4 and Urbanczyk 1992:Figure 7; see Plate 8.2), had to take place in Skeos or caves in the north of Scotland. The regulations of the Federation of Norwegian Fishing Industry suggest that stockfish must be dried only at times when climatic conditions are favourable (Fiskerinæringens Landsforening n.d.:79-80). The warmer conditions of northern Scotland must have limited the potential scale of stockfish production through the necessity of drying indoors and the frequent danger of spoilage. These factors, combined with historical evidence that salt was imported to the earldoms by at least the 14th century (Burnett 1878:308), suggest that dry salting may have been the primary fish curing method in the northern earldoms.

To summarise the historical evidence, it is probable that both stockfish and dry salt fish were made in the Late Norse and post-medieval earldoms. The latter may, however, have been more common. These fish were probably decapitated and (based on a 15th century Hanseatic edict and 16th century Icelandic analogies), some vertebrae were possibly removed during splitting. Evidence regarding appendicular elements is inconclusive.

The pictorial evidence has an immediately satisfying quality, but it all derives from the 15th century and later. Fifteenth and early 16th century seals of the Hanseatic Kontor in Bergen all included a crowned headless stockfish. The earliest impressions of these seals survive from 1415 and 1462 (Trætteberg 1975:145-148). Plate 8.9 illustrates an example from 1507 kindly supplied by the Archiv der Hansestadt Lübeck (A. Graßmann pers comm.). The single most important feature is that the fish is decapitated (although the possibility that this was simply a heraldic convention must be accepted). A similar headless fish (probably an early version of the arms of Iceland officially granted in 1593, see Trætteberg 1975:147) appears on Olaus Magnus' *Carta Marina* of 1539 (Plate 8.10; Lynam 1936). Market fish, *forvmpiscivm*, are illustrated in northern Norway on the same map (Plate 8.11). Some appear to be split (raising the possibility that at least anterior vertebrae were removed) and decapitated, possibly with the tails left on. Others are complete, including heads, but it is difficult to know if this last group are cured or simply waiting to be processed.

Olaus Magnus' *Historia de Gentibus Septentrionalibus* of 1555 also includes useful woodcut illustrations, such as Plate 8.12 which may illustrate split salt cod hanging in the upper left hand corner. The tails appear to be intact (indicating that some caudal vertebrae would be in place) and the distinct concave curve at the anterior end of the fish may imply that cleithra were also left in situ. Other fish in the diagram are complete, or possibly even filleted. It is possible that these represent different species, such as herring, but the possibility of diverse curing practices is illustrated once again. The associated text reveals little detail of present relevance, except to note that cod, *torsck*, was among the taxa commonly salted (Magnus 1555:723).

As Olaus Magnus, an Archbishop of Upsalla, published these works while exiled in Rome (Lynam 1936:3), it is worth considering the reliability of his depictions of west Norse customs. It is reassuring to some degree that he had visited Norway and spent part of his youth in the seaports of north Germany, the geographical focus of Hanseatic fish trade with Scandinavia (Sigurdsson 1984:397-398).

The seal of the Hanseatic kontor in Bergen and Olaus Magnus' woodcut illustrations are consistent with the pattern of fish butchery established by the historical evidence. It would appear that cured fish were decapitated and sometimes split - suggesting the removal of at least anterior vertebrae - in western Scandinavia during the 15th-16th centuries. Caudal fins may also be intact in a few illustrations, which implies that posterior vertebrae remained in at least some finished products. This procedure is also likely on anatomical grounds. It is difficult to remove these elements without completely dividing a fish into two fillets. One illustration from Olaus Magnus also suggests that cleithra (and by implication, other appendicular elements) were at least occasionally left in cured fish. In total, one can envision that only skull bones and anterior vertebrae might be consistently discarded at a processing site.

The weakness of the pictorial evidence lies in its late date. The pattern of butchery it suggests, however, can be identified in the zooarchaeological record from earlier centuries. Much of the currently published information derives from regions where stockfish were consumed rather than produced. It is likely, however, that at least some of this material was imported from western Scandinavia.

Thomas Amorosi (1991:279; see also Amorosi 1989a:210) has suggested that "there were far more cranial fragments than vertebral elements" recovered from 15th century levels at Storaborg, southern Iceland. Regrettably, however, the quantitative publication of these data is still awaited. The results of recent work by Sophia Perdikaris (forthcoming) on assemblages from Arctic Norway will also be enormously useful. Presently, however, the best evidence derives from German, Dutch and English contexts in which suggestive element distributions and cut marks have been recognised in the remains of gadoid fishes.

Alwyne Wheeler (1977) has pioneered attempts to recognise imported cured fish products in medieval England. He suggested, on the basis of contemporary fish distribution data, that ling and halibut represented in 13th to 14th century levels at King's Lynn were probably imported from northeast England or Scotland. Regrettably, however, there are insufficient published data to assess the relative distribution of elements in this material.

Wilkinson's (1979) classic study of fish bones from medieval and post-medieval Exeter reveals a suggestive case for the importation of cured cod. In the post-medieval phases, bones of the appendicular skeleton (44 cleithra, 19 supracleithra and 9 posttemporals) substantially outnumbered cranial specimens (5 premaxillae, the most abundant element). Moreover, caudal vertebrae outnumbered abdominal vertebrae despite their smaller size and the fact that the assemblage was hand collected (Wilkinson's 1979:74-75, 214). It is tempting to use these data to define a pattern of cured fish production similar to that described by Low in 1774 (see Section 8.2.3 above). Before applying this model to northern Scotland, however, it is necessary to ask where and when these putative cured cod were produced. The post-medieval designation in Wilkinson's report, 1500-1800, is unfortunately broad. Moreover, Exeter was heavily involved in the Newfoundland fishery by the seventeenth century (Wilkinson 1979:80).

Dirk Heinrich (1983; 1986a; 1986b; 1987; 1994) has discussed possible finds of cured cod family fish in the towns of medieval Denmark and Germany. The largest assemblage which can be dated exclusively to the middle ages comes from 11th-14th century contexts in Schleswig (Heinrich 1983:152; Heinrich 1987:91-92). In a collection of 1089 hand collected cod bones there were 62 cleithra (the best represented element of the appendicular skeleton) compared to 20 dentaries (the best represented cranial element). Both abdominal and caudal vertebrae were also abundant. (see Table 8.1). Only five cut marks were identified, but four of these were on abdominal vertebrae and probably derived from decapitation (Heinrich 1987:108-109).

In order to determine the geographical origin of these cod, Heinrich (1987:101-108) studied their growth rates by osteometry and counting annual rings in vertebrae. He found that a reduction in growth rate, implying the onset of sexual maturity, occurred between 4 and 8 years in 90 of 124 examined vertebrae. The remaining 34 vertebrae exhibited no discernible change in growth rate despite a minimum total length of >70cm (Heinrich 1987:107). The onset of sexual maturity between 4 and 8 years could be consistent with fish of North Atlantic, local or mixed origin. Modern North Atlantic cod stocks mature after 6 years at lengths between 70-100cm whereas the cod available in Danish and German waters mature between 2 and 6 years at a minimum length of c.35cm. However, the absolute lengths of over 70cm attained by the fish represented in Schleswig at ages of 7 or more years are much more consistent with a North Atlantic origin (Heinrich 1987:108). Assuming, on the basis of this growth rate study, that the fish in Schleswig did derive from a North Atlantic (presumably Scandinavian) source, we might envision the manufacture of a decapitated product in which the appendicular skeleton and at least some caudal and abdominal vertebrae were left in situ.

Heinrich (1987:90) also synthesises results from Lübeck, a centre of the Hanseatic stockfish trade with Scandinavia. Vertebrae have been recovered and the appendicular skeleton is better represented than the skull (155 elements to 141 elements). It is impossible, however, to draw firm conclusions from this material. It derives from sites which are extremely broadly dated from the 12th to the 20th centuries.

Heinrich's (1994; in press) more recent results from three German sites, Bodenteich castle (13th - 18th centuries), Plesse castle (15th - 17th centuries) and the town of Hoxter (early 17th century), provide an interesting footnote to the Schleswig material. Once again, vertebrae and bones of the appendicular skeleton such as cleithra outnumber even robust cranial elements such as dentaries and premaxillae. At Hoxter, for example, there are 8 cleithra, 1 coracoid, 1 basipterygium, 1 abdominal vertebrae, 12 caudal vertebrae and no cranial elements of cod family fishes (Heinrich in press:Table 2). Although the number of gadoid bones at all three sites is tiny (26 specimens from Bodenteich, 66 from Plesse and 25 from Hoxter) they include haddock (more likely to be caught in the North Sea or Atlantic than local waters) and torsk (an arcto-atlantic species unlikely to be found in the Baltic or southern parts of the North Sea) as well as cod (Heinrich 1994:213-214; see also Heinrich 1983:151; Whitehead et al. 1986a:687, 697). It thus seems likely on zoogeographic grounds that this material arrived as cured fish, possibly from Scandinavia (although by the 16th century a New World origin is not impossible). It is perhaps relevant to mention that torsk was a major component of the Shetlandic cured fish trade when first described in detail by Low (1813:200).

Perhaps the best example of cured cod family fish of probable northern origin comes from the wreck of the late 16th century merchant ship Scheurrak SO1 (Brinkhuizen 1994; pers comm.). Three barrels were recovered containing cod, torsk and ling, all of which had been decapitated anterior to the appendicular skeleton. Barrel 1 contained cod with the abdominal vertebrae and anterior portion of the caudal vertebrae also removed. Barrels 2 and 3 contained cod, torsk and ling, some of which were probably processed the same as the fish in barrel 1. Others, however, were cured with some or all of the abdominal vertebrae left in situ (see Table 8.1).

Several other tentative identifications of 'imported stockfish' from late medieval or early modern sites in continental Europe do not provide sufficient data for model building. Arturo Morales et al. (1991) have tentatively identified imported cured cod and hake at the 15th-16th century monastery of Santa Mairia de las Cuevas. The faunal material was consistent with fish that had been decapitated but retained appendicular elements and some caudal vertebrae. This conclusion, however, is based on only 4 cod and 29 hake bones. Ijzereef and Laarman (1986:435, 437-438) argue that 57 Gadidae vertebrae from 9th-16th century Deventer derived from stockfish. As they only identified vertebrae, however, it is impossible to reconstruct butchering patterns from their data (Ijzereef and Laarman 1986:435).

Overall, this archaeological evidence is consistent with the model of cured fish production suggested by the historical and pictorial record. Most significantly, it confirms that appendicular elements were often exported in the finished product and that anterior abdominal vertebrae were sometimes removed (to remain at a processing site). The evidence does not derive from the earldoms, but at least the German assemblages studied by Heinrich were likely supplied from Scandinavia. The presence of torsk in the Dutch wreck assemblage may imply that it too came from the northeastern North Atlantic.

Taking the historical, pictorial and archaeological evidence as a whole, it seems reasonable to suggest a flexible model of stockfish and salt dry fish production in Late Norse Orkney, Caithness and Shetland. Only some evidence derives directly from the earldoms, but the broad patterns identified may have been relatively consistent among the Scandinavian settlements of the North Atlantic. Regional variability occurred, as the Hanseatic edict of 1494 makes explicit. Nevertheless, subtle differences are unlikely to affect a flexible and imprecise model.

To articulate the model in explicit terms, it is likely that fish were usually decapitated - potentially leaving skull bones at a processing site. Conversely, elements of the appendicular skeleton such as the:

posttemporal (a cranial element in the true sense, but appendicular in location),
supracleithrum,
cleithrum,
postcleithrum,
scapula,
coracoid and
basipterygium

were at least sometimes left in cured products. Posterior, particularly caudal, vertebrae usually also remained in processed fish, but some or all abdominal (and anterior caudal) vertebrae could be either cut out *or* left in situ. They may or may not be expected to remain at a processing site.

Given this model, it is now possible to assess patterns evident in Late Norse fish assemblages such as Robert's Haven and Earl's Bu. It may be possible to identify whether cured fish were produced and/or consumed at these sites. The model may also prove relevant to the Viking Age, but this possibility would have to be established inductively by examination of zooarchaeological data. The evidence discussed above derives predominately from the 14th to 16th centuries. It would thus be unwise to extrapolate the results beyond the boundaries of the Late Norse Period or, preferably, its latest sub-division (LN2).

8.3 The Robert's Haven Fish Assemblage

8.3.1 Introduction

Robert's Haven, the Late Norse fish midden site introduced in Chapter 5 and 7, was investigated in order to produce a closely dated, well preserved and adequately recovered fish bone assemblage which could be compared with this flexible model of medieval fish curing. As discussed in Chapter 1, previous attempts to identify the residue of fish curing in the Norse earldoms have proven inconclusive due to recovery, preservation and analytical complications. Robert's Haven provides an opportunity to overcome these problems.

8.3.2 Recovery and Quantification Procedures

Why is Robert's Haven different? How can it help to provide conclusions which have proven elusive in previous studies? As discussed in Chapter 7, the fish midden (Area A) at Robert's Haven resembles similar deposits at Freswick Links (Morris et al. forthcoming a) and possibly also Quoygrew (Colley 1983a:208-212), Sandwick (Bigelow 1984:90-135) and St. Boniface (Cerón-Carrasco 1994; forthcoming; Lowe 1990; 1993). The important differences lie in bone preservation, sampling strategy and analytical procedures.

The Robert's Haven deposits are calcareous (pH ranges from 7.1 to 8.8, see Appendix 5.2) and largely undisturbed. Even fragile fish fins and patches of articulated scales remained intact. A total of 207 examples of articulated fin rays, scales and bones (principally vertebrae) were recovered from 23 stratigraphic contexts in the three sample columns of Area A. Post-depositional bone preservation conditions are ideal. Taphonomic blurring is reduced to the minimum that can be expected for free draining deposits in a temperate environment.

As discussed in Section 5.3.2, sampling procedures were conceived to take advantage of this exceptional preservation. All excavated sediment was wet-sieved to 1mm (heavy fraction) and 0.5mm (floating fraction) using a modified Siraf tank (Wheeler & Jones 1989:51-57). The heavy material was subsequently re-sieved to greater and less than 4mm in the laboratory, with the >4mm fraction comprehensively sorted for all cultural remains. Fish vertebrae, dentaries, premaxillae and otoliths (in addition to small mammal bones) were also sorted from the <4mm fraction. The latter procedure makes it possible to assess the relative abundance of posterior caudal vertebrae which would be lost through larger screen sizes or hand collecting procedures (see below). Moreover, all clusters of articulated fish bones (one taphonomic step from the primary waste of fish processing) were excavated and bagged individually. They provide an avenue for the study of fish processing techniques which can supplement the traditional method of comparing relative element frequencies of entire assemblages.

Fish bones recovered from the >4mm sample fraction were divided into four quantification categories (Q1 to Q3 and 'unidentified cod family') which were identified to different taxonomic levels. Fragments which belonged to taxa other than Gadidae composed a tiny proportion of the assemblage (1527 of 492203 >4mm fragments, 3.2%) and will not be discussed in detail here. They will be published in a forthcoming Robert's Haven site report.

First, nine Gadidae elements (constituting 16 bones per skeleton considering paired elements) were identified to the smallest possible taxonomic level, usually species. These quantification category one (Q1) bones include the articular, cleithrum, dentary, maxilla, parasphenoid, posttemporal, premaxilla, quadrate and vomer. Practical experience and some experimental research have shown that these robust, species diagnostic, elements tend to survive in a recognisable form (Barrett 1992a:56-57; Colley 1990:212; Leach 1986:151-152; Nicholson 1991:510; 1992b:145; Wheeler 1978b:70). The cleithrum (which is probably less robust than the others, see Section 1.3.3 and Figures 7.16-7.18) was included in this list as it is the largest appendicular element. It is thus relevant to the cured fish model developed above. The routine identification of only Q1 bones to species avoids needless duplication of taxonomic, size and other data.

Data was collected using pro forma record sheets which were then entered into a relational database for computer assisted analysis. Most or all of the following information was recorded for Gadidae elements of quantification category one:

Specimen Number,
Provenience,
Taxon,
Element,
Portion,
Percent,
Quantification Category,
Texture,
Taphonomy,
Size,
Measurement 1,
Measurement 2,
Weight,
Side and number and
Comments.

The first datum, specimen number, was used only for bones with cultural alterations or other features which might need to be re-examined. In these cases, the number assigned was also written directly on the specimen using permanent ink. Provenience includes the sample and context from which an element came. Under taxon, bones were identified to species, genus, genus group (e.g. *Gadus/Pollachius*) or family as their state of preservation allowed. Taxonomic terminology, including English names, follows Whitehead et al. (1986a; 1986b; 1989). Element is self explanatory. The terminology and abbreviated codes used in this study were adapted from Wheeler and Jones (1989:89, 93, 99-100, 103, 122-124).

Portion was recorded as a code of from one to four digits indicating which diagnostic zones of an element were represented by a given archaeological specimen (see Watson 1979 for a discussion of diagnostic zones in zooarchaeology). Appendix 8.1 illustrates the diagnostic zones originally used in this study and a second, modified, system based of my experience using the first. The numbering system developed over several years and could be made more systematic for future use. Percent is a qualitative assessment (in 20% increments) of the proportion of a total element represented by a surviving specimen (the completeness scores discussed in Section 7.2). The quantification category entry facilitates computer separation of the elements routinely identified to species (i.e. Q1) from other bones (which will be discussed below). Texture is a qualitative assessment of the degree of microstructural damage to a bone. A scale from one (hard and resilient surface, sometimes glossy) to three (soft, flaky and/or powdery surface) was used. Bone alterations such as burning, cut marks and tooth marks were recorded under the heading taphonomy.

Size estimates, based on comparison with reference specimens from fish of known total length (TL), were attempted for every element identified to species. The size categories used were:

Tiny (T)	<150mm
Small (S)	150 to 300mm
Medium (M)	300 to 500mm
Large (L)	500 to 800mm
Very Large (X)	800 to 1000mm
Extremely Large (XX)	>1000mm

More precise size estimates were also attempted using two measurements taken on premaxillae and dentaries whenever they were adequately preserved. The measurements are based on Jones (1991a:58) and are illustrated in Figure 8.1. The equations used to predict total length, also based on Jones' work (1991a:164), are:

Cod

$$\text{Total Length (mm)} = 70.795(P1)^{0.99}$$
$$\text{Total Length (mm)} = 112.202(P2)^{0.95}$$

$$\text{Total Length (mm)} = 138.039(D1)^{0.86}$$
$$\text{Total Length (mm)} = 154.882(D2)^{0.80}$$

Saith

Total Length (mm) = $74.131(P1)^{1.10}$
Total Length (mm) = $169.824(P2)^{0.93}$

Total Length (mm) = $91.201(D1)^{0.93}$
Total Length (mm) = $91.201(D2)^{0.89}$

Ling

Total Length (mm) = $109.648(P1)^{0.97}$
Total Length (mm) = $173.780(P2)^{0.83}$

Total Length (mm) = $181.970(D1)^{0.79}$
Total Length (mm) = $213.796(D2)^{0.73}$

Haddock

Total Length (mm) = $89.125(P1)^{1.06}$
Total Length (mm) = $144.544(P2)^{0.92}$

Total Length (mm) = $158.489(D1)^{0.95}$
Total Length (mm) = $165.959(D2)^{0.98}$

Measurements were taken with dial calipers to 0.1mm. When both measures could be collected from a single specimen, the datum with the clearest measuring points was preferred. For dentaries, D2 was always preferred. P1 provided the best measuring points for premaxillae.

The weight of each specimen was measured to the nearest 0.1g, or the nearest 0.01g for elements weighing less than 0.1g. Side was recorded for bilateral elements and the comments column provided space to describe taphonomic alterations or other particular features of each specimen.

The second quantification category (Q2) included Gadidae vertebrae. They were identified to species, or to the combined category *Gadus/Pollachius*, (including cod, saith and pollack) whenever possible. Vertebrae of the latter three taxa can be differentiated (e.g. Boyle et al. 1992), but it is often very difficult to do so with fragmentary specimens. Any attempt to quantify the vertebrae of cod, saith and/or pollack at the species level would inevitably be complicated by a large group of undifferentiated specimens. It is not surprising, therefore, that zooarchaeologists have sometimes chosen not to identify all Gadidae vertebrae to species (e.g. Jones 1991a:55-56; Nicholson n.d.b:5). An attempt was made, however, to identify even these vertebrae to the smallest possible taxonomic category if they exhibited evidence of cultural modification (such as cut marks or burning).

The data entry form described above was also used for Gadidae vertebrae, but only the following information was routinely collected: provenience, taxon, element, part, quantification category, weight and number. Moreover, multiple examples of the same element were given a single entry with the appropriate number and a combined weight. All data fields were filled for specimens exhibiting cultural modifications.

Gadidae vertebrae were identified as belonging to one of eight groups. These included the first vertebrae (FV), abdominal vertebrae groups one to three (AV1, AV2, AV3), caudal vertebrae groups one and two (CV1, CV2), penultimate vertebrae (PUV) and ultimate vertebrae (UV). Table 8.2 presents the number of vertebrae in each category for the Gadidae taxa identified at Robert's Haven. These values are based on averages from four or five reference specimens of the most common species (cod, saith, and ling) and on single specimens for trace taxa (haddock, whiting, torsk and rockling).

The diagnostic criteria of each vertebral group are based on a system used by Andrew Jones (pers comm.). Although they vary from taxon to taxon, a discussion regarding cod can serve as a general guide. The first vertebrae is characterised by two anterior processes which articulate with the exoccipitals of the neurocranium. The four abdominal vertebrae of group one have rounded ventral surfaces and no transverse processes. The second group of abdominal vertebrae includes five elements with transverse processes set laterally, almost precisely in the frontal plane (although these processes do begin to point ventrally on the last few specimens). AV2 elements can also be identified by a longitudinal asymmetrical grove on the ventral surface of each centrum. Abdominal vertebrae group three (usually eight in cod) exhibit symmetrical groves on the ventral surface and have transverse processes which are angled down. The first 14 caudal vertebrae have neural and haemal spines which form an angle of greater than 30° with the axis of the centrum. The spines of caudal vertebrae group two are more acutely angled and centrum morphology changes from anterior to posterior. Penultimate vertebrae are easily recognised by dorsal and ventral pits, and by the absence of spines. Ultimate vertebrae are characterised by a single articular facet.

Most other Gadidae elements, quantification category three, were identified to the level of family. As they differ in robusticity, the relative representation of these elements can provide useful information regarding the taphonomic history of the assemblage (see Sections 1.3.3 and 8.4.2). Only provenience, element, quantification category, weight, side and number were routinely recorded. As with vertebrae, multiple examples of the same element were recorded as a single record and all possible data were collected for modified specimens. Quantification category three (Q3) elements include the:

Basibranchial	Basioccipital
Basipterygium	Ceratohyal
Coracoid	Ectopterygoid
Epihyal	Ethmoid
Exoccipital	Frontal
Hyomandibular	Interhyal
Interopercular	Lacrimal
Lower Hypohyal	Opercular
Opisthotic	Otolith
Palatine	Prefrontal
Preopercular	Prootic
Pterotic	Scapula
Sphenotic	Supracleithrum
Supraoccipital	Symplectic
Upper Hypohyal	Urohyal

All other specimens (excluding those which could be identified as belonging to families other than Gadidae) were counted, weighed and classified as unidentified cod family. This group includes both unidentifiable fragments of bones which, if recognisable, would belong in the other quantification categories and a few elements which were simply not worth identifying. The time necessary to identify ceratobranchials, branchiostegals, lepidotrichia and pterygiophores, for example, was not thought worth any additional information they might provide. Every unidentified fragment was examined for cultural modifications or features indicative of another taxonomic family. A few 'unidentified cod family' specimens may belong to taxa other than Gadidae (and the closely related hake, which has been treated as a cod family taxon). However, careful examination combined with the tiny proportion of non-Gadidae specimens in the entire assemblage ensures that any such fragments will not be numerically significant.

The dentaries, premaxillae, vertebrae and otoliths recovered from the <4mm sample fraction were analysed following the same procedure. They were identified with an additional data field labeled sieve size. These elements are of vital importance in all analyses where bone or fish size are of relevance. Bones collected as articulated groups ("articulations" hereafter) were also recorded following the above procedures. In addition, however, all were recorded separately as groups and identified to species and size whenever possible.

8.3.3 Intra-assemblage Variability

Bone from all samples of the Area A fish midden have been combined as a single assemblage for the following analysis. As discussed at length in Section 7.3.3 there is ample evidence to suggest that it is valid to treat this deposit as a single feature type and analytical unit. Survey and excavation strongly suggest that the midden accumulated rapidly and represents a relatively consistent range of past activities. These factors are crucial given the modest excavation area. Numerous subdivisions of the bone assemblage would lower the sample size per analytical unit below the limits of useful interpretation.

8.3.4 Taxonomic Results

In total, 49234 individual specimens weighing 11907.37g were recovered from the >4mm sample fraction. The vast majority of these specimens, 447707 weighing 11754.87g, derived from the cod family, Gadidae (see discussion of the *unidentified cod family* category in Section 8.3.2 above) and, to a much smaller extent, the closely related hake family, Merlucciidae. Only 1527 specimens weighing 152.5g belonged to other taxa. Of the <4mm sample fraction, from which three cranial elements (dentaries, premaxillae and otoliths) and vertebrae were sorted, 2082 Gadidae elements weighing 31.99g and 598 non-Gadidae elements weighing 4.80g were recovered. In total, 51914 fragments weighing 11915.7g were examined.

The following results are, except where noted otherwise, derived exclusively from the >4mm sample fraction. Information from the <4mm fraction is generally used retrospectively to identify any likely biases in the >4mm data. Estimates of relative species abundance are based exclusively on quantification category one data unless indicated otherwise.

The Gadidae and Merlucciidae taxa identified are tabulated in Table 8.3. For convenience, the two closely related families are collectively referred to as "Gadidae" or "cod family" in subsequent discussion. Non-Gadidae specimens are not of immediate relevance in this chapter, but most are from gurnards (Triglidae) and herring (*Clupea harengus*). Other taxa, such as dogfish (including *Squalus acanthias* or *Etmopterus spinax*), ray (Rajidae), wolf-fish (*Anarhichas lupus*) and flatfish

(Heterosomata) are present only as trace species. Of the 47707 Gadidae (or probably Gadidae) fragments examined, 2929 derived from quantification category one bones, 6934 were vertebrae and 5271 belonged to quantification category three. The remainder were unidentified cod family.

Gadidae specimens were identified by comparison with reference skeletons housed in the Department of Archaeology, University of Glasgow, which were supplemented by material examined in the Environmental Archaeology Unit, University of York, and by advice solicited from Dirk Heinrich. Published and unpublished identification manuals were also of significant value (Amorosi 1988; Boyle et al. 1992; Harkonen 1986; Jones 1991a:167-181). Ling specimens have been classified as *Molva cf. molva* to reflect the possibility that a few bones in this category could actually derive from the related species *Molva dipterygia*. It seems unlikely that the latter is abundant, however, given its offshore distribution and deep water habitat (e.g. Muus & Dahlstrøm 1974:114).

Three species constitute 71% of the Gadidae assemblage. Cod (and ?cod), represented by 980 Q1 elements, is the most abundant taxon (34%). Saith (and ?saith) with 826 Q1 specimens, is a close second (28%). Ling (and ?Ling) is the third most abundant taxon, with 270 Q1 bones (9%). All other Gadidae and Merlucciidae taxa together, excluding the gross categories Gadidae, *Gadus/Pollachius* and *Pollachius* which are almost certainly dominated by the primary three species, account for only 135 Q1 specimens (5%).

This picture is only slightly altered by examination of data from the <4mm sample fraction (see Table 8.4). Cod (155 dentaries, 33%), saith (132 dentaries, 28%) and ling (35 dentaries, 7%) remain the dominant species when elements sorted from both size fractions are compared. Although rockling (including ?rockling) are more common in the <4mm than in the >4mm sample fraction, they remain less than 0.1% of the total gadoid assemblage by fragment count (Table 8.4).

8.3.5 Differentiating Primary Deposition of Fish Processing Waste and Secondary Deposition of Fish Consumption Waste

As discussed in Section 7.5, Area A at Robert's Haven contains a background component of domestic rubbish. It is highly probable that some fish bone entered the midden from this source. Before investigating the assemblage further, it would thus be useful to consider how much bone was the product of primary fish processing (conceivably for export) and how much entered the midden during housecleaning. As illustrated by Figures 7.29-7.31, these components (or "taphonomic groups", see

Gautier 1987) cannot be isolated on stratigraphic grounds. The correlation of carbonised vegetation and fish bone strongly suggests that household rubbish (including hearth contents) was spread on the Area A midden concurrent with primary fish processing waste. As suggested in Section 7.3.3, this may have been a purposeful procedure intended to control odour and deter scavengers.

It may be possible, however, to use characteristics of the fish bones themselves to identify the quantity which entered the midden as household rubbish. Four characteristics can be explored: fragmentation, fire alteration, evidence of ingestion and fish size.

First, it is possible that re-deposited household rubbish would be less well preserved than processing waste left in its primary context. Bone in or around a dwelling might be subject to greater trampling than in a specialised fish processing area. Moreover, household rubbish might have served as animal food or bedding (See Fenton 1978:195; Urbanczyk 1992:34) - exposing it to even greater destructive forces (e.g. Greenfield 1988) - before finally being transferred to the Area A midden. The latter processes could explain the presence of herbivore dung, unburned turf (possibly bedding), and monocotyledon leaves (possibly fodder or bedding) in the Area A deposits (see Section 7.5 and Simpson & Barrett forthcoming). Figure 8.14 provides a useful illustration of some of these potential taphonomic processes.

As noted in Chapter 7, the distribution of dentary *bone weight survival estimates* for cod exhibits a hint of bimodality (see Figure 7.25). In the distribution of 119 dentaries for which this statistic could be calculated, possible modes are evident at c.20% and c.60%. It is tempting to interpret the lower group as a more trampled product of domestic rubbish. It is difficult to sustain this argument, however, in light of evidence from other bones.

Cod premaxillae, the other element for which *bone weight survival estimates* were calculated, exhibit a relatively normal distribution (see Figure 7.27). Less precise, but similar in implication, are the distributions based on completeness scores available for all Q1 bones from cod, saith and ling. These distributions have been explained and illustrated in Chapter 7 (see Figures 7.16-7.18). It is necessary to note here, however, that only three of 27 species level distributions exhibit any convincing evidence of bimodality (cod premaxillae, cod articulars and ling premaxillae).

It is possible that the completeness score distributions, based on only 5 subdivisions in 20% intervals, are too imprecise to show real bimodality in the degree of bone damage. For example, the distribution for cod dentaries (see Figure 7.16) does not reveal clear evidence of the bimodal pattern suggested in Figure 7.25. Nevertheless, the normal distribution of the premaxillae *bone weight survival estimates* and the virtual absence of bimodality among the completeness score data negates the possibility of using degree of bone damage to identify locally consumed fish.

Burned bones may provide a better solution. It is perhaps safe to assume that bones with evidence of burning derived from food prepared within a dwelling - the waste from which made its way into a hearth. This possibility seems likely given the absence of evidence for in situ burning of the Area A midden. Ethnohistoric analogy from early modern Orkney provides a useful example of how bones from fish eaten locally might come in contact with fire. Traditional Orcadian (and Norse) houses had central hearths on which cooking was performed (Fenton 1978:195-204). As ash accumulated, it was scraped into a hearth-side depression, lined with a basket or mat, and sometimes surrounded by wet peat to contain the fire. This depression served as a repository for household trash until full. It was then removed to the household midden, either directly, or by way of a byre where it would serve as animal bedding (Fenton 1978:195-197). The waste from household activities could all end up in the ash pit, and some presumably in the adjacent hearth, where heat alteration was likely to occur.

In total, 1984 Gadidae bones (including 'unidentified cod family') exhibited evidence of heat induced colour changes ranging from dark brown or black to white (Nicholson 1993b:414). These bones constitute 4.2% of the cod family assemblage of 47707 specimens. The species represented by fire altered specimens are the same as those in the complete assemblage, with the exception of trace taxa such as whiting, torsk and rockling which do not appear among the burned bones (see Table 8.5). The rank order of taxa is also similar to that exhibited by the assemblage as a whole, with cod, saith and ling dominant. It is interesting, however, that ling (47 Q1 specimens) are more commonly burned than cod (42 Q1 specimens) or saith (18 Q1 specimens, see Table 8.5). This may simply reflect the degree to which robust ling bones are likely to survive exposure to fire. It is also possible, however, that ling were more frequently burned (and thus, by the logic of the current argument, more often eaten locally).

Treating the species individually, 4.3% of cod, 2.2% of saith and 17.4% of ling Q1 bones exhibited fire alteration. A comparison of dentaries, premaxillae and vertebrae recovered from both the >4mm and <4mm sieve fractions suggests that these data are not substantially biased by recovery (see Table 8.6).

It is difficult to estimate the implications of this information without some knowledge of the ratio of burned to unburned fish bones in the domestic rubbish of Robert's Haven. Using the assemblage from Earl's Bu (see Section 8.5 below) as a model of domestic rubbish, however, it would appear that a figure of 4.2% burned specimens is not inconsistent with the entire assemblage having derived from consumption waste. The proportion of burned specimens among the gadoid bones from Earl's Bu is 5.8%. As discussed in Chapter 7, however, the concentration of fish bone in Area A at Robert's Haven is entirely unlike consumption deposits such as Earl's Bu. In summation, it may only be possible to suggest that the component of re-deposited fish consumption waste in Area A was moderately large.

It is also worth considering briefly whether bones which exhibit crushing, partial digestion or tooth impressions (Tables 8.7-8.9) entered the midden as human faeces. Research by A. Jones (1986) and Wheeler and Jones (1989:73, 75) has illustrated that crushed fish bones (particularly vertebrae) can derive from human mastication and that partial digestion causes diagnostic surface alterations such as erosion and polishing. Tooth impressions could conceivably also derive from mastication by humans.

This evidence, however, is more consistent with carnivore (perhaps dog) than human consumption. Many of the 67 specimens with tooth marks exhibit the punctate depressions and striations characteristic of carnivore gnawing (Lyman 1994:205-210; Stallibrass 1990:159). Moreover, crushing (represented by 266 specimens) and partial digestion (evident on 103 bones) are also caused by piscivores other than humans (e.g. A. Jones 1986:55; Lyman 1994:204-205, 211; Stallibrass 1990:153-155; Wheeler & Jones 1989:73). Amorphous material tentatively identified as mineralised faeces, recovered from 17 contexts in Area A, is also consistent with a non-human origin. It contains polished fragments of mammal bone similar to those recovered from canid scats (see Stallibrass 1990:153-155, 159).

If, as argued above, burned bones derived from re-deposited domestic rubbish some *ingested* specimens probably originated from housecleaning waste. Nine bones were *both crushed and burned* and one element exhibited *both tooth impressions and charring*. Perhaps some carnivore (dog?) faeces were swept into hearths prior to disposal. It is also likely that some crushed, digested and gnawed bone derived from scavenging of the fish midden itself.

Total length estimates represent a final potential tool for differentiating the bones of fish used for local consumption and (possibly) export. In his discussion of fish bones from Sandwick, Shetland, Bigelow (1984:132-133, 199, 217-218; 1985:121) suggested that small gadids, (particularly saith of <400mm estimated total length) were caught for local consumption while larger cod family fish were intended for export. This model was based on ethnohistoric analogy and on a bimodal distribution of fish sizes in the Sandwick assemblage.

The distribution of saith and cod total length estimates is also bimodal for Robert's Haven (see Figures 5.26 and 5.27). However, all sizes of fish were eaten locally if it is safe to assume that burned bones derived from domestic rubbish. Figure 8.2 illustrates the total length estimates suggested by comparison of fire altered Q1 bones with analogous elements from fish of known size. Although the resulting distributions may be affected by bone shrinkage during heating, they are not unlike those for the Gadidae assemblage as a whole. There is no evident focus on small fish.

These data could be biased by the use of 4mm sieves. However, the size distributions of elements sorted from both the >4mm and <4mm sample fractions confirm that small saith, cod and ling were probably not the exclusive focus of disposal by burning or, by implication, local consumption (Figure 8.3).

To investigate this issue further, the relationship between fish size (estimated total length) and bone preservation (*bone weight survival estimates*) was examined for cod (Figure 8.4). Following the argument raised above, the bones of smaller fish might be more poorly preserved if they entered the midden as re-deposited domestic rubbish. This result is not evident. There is no correlation between fish size and bone preservation. Furthermore, a few of the smallest specimens are actually the best preserved bones.

It is also relevant that virtually every excavated Viking Age and Late Norse fish assemblage from the earldoms exhibits a bimodal distribution of cod and saith lengths (see Figures 5.29-5.50). As discussed in Section 5.6, this pattern may relate to the existence of distinct shore and boat based fisheries.

To synthesise these investigations, it is evident that a component of the Area A fish assemblage derived from re-deposited domestic rubbish rather than primary fish processing waste. Nevertheless, the two 'taphonomic groups' cannot be isolated on the basis of stratigraphy, fragmentation, evidence of ingestion or estimated fish size. Fire altered bones, which comprise 4.2% of the assemblage, provide the only quantitative data with which to interpret the domestic rubbish component. The comparable proportion of burned bone in Area A from Robert's Haven and a domestic midden from Earl's Bu suggests that the quantity of local consumption waste in the fish midden is considerable. However, the simultaneous deposition of processing and consumption waste (suggested by correlation of the density of fish bone and burnt peat in the deposits, see Section 7.3.3) makes it unrealistic to separate the two groups prior to further analysis of the fish bone. It must simply be kept in mind that any patterns created by the production of cured fish may be somewhat blurred by waste from the consumption of fresh catches.

8.4 Testing the Cured Fish Model

8.4.1 Introduction

In Section 8.2 it was established that gadoid fish cured for export to medieval Europe probably contained bones of the appendicular skeleton and some or all of the vertebral column. Conversely, cranial bones and an anterior portion of the vertebral column might remain at processing sites. A number of factors, however, could complicate this simple pattern. Fish heads might have been discarded at sea (e.g. Low 1879[1774]:132), used as animal fodder (e.g. Urbanczyk 1992:34) or spread on agricultural fields as manure (e.g. Withrington & Grant 1979[1791-1799]:244). Conversely, whole (or processed) fish which spoiled might have been added to processing middens. Finally, Section 8.3.5 has illustrated that some bones from locally consumed fish were probably disposed in Area A - even if the midden was primarily derived from production for export. These processes, combined with the different preservation potential of the skeletal elements under consideration (see Section 1.3.3 and Figures 7.16-7.18), ensure that Area A cannot be expected to yield only fish heads and anterior vertebrae even if it was a fish curing station.

Despite these potential sources of statistical 'noise', it is reasonable to assume that a midden created by cured fish processing might exhibit some patterning consistent with the model outlined in Section 8.2.4. It is proposed to investigate this possibility following four lines of inquiry. Firstly, the relative abundance of cranial and appendicular bones will be compared for the most common gadoid taxa. Secondly, the relative representation of eight different sections of the vertebral column will be assessed and compared with the abundance of cranial elements. Thirdly, bones recovered as articulated groups (articulations) will be examined for evidence of fish processing methods. Finally, a study of cut marks may provide evidence regarding butchery practices which can compliment the preceding examinations of element representation.

8.4.2 A Comparison of Cranial and Appendicular Elements

Table 8.10 presents the abundance of all quantification category one elements for the three dominant taxa (*Gadus*, *Pollachius* and *Molva*) and the cod family as a whole. The number of specimens for single mid-line elements has been doubled to facilitate direct comparison with paired elements. It is immediately evident that cleithra are significantly underestimated in Gadidae as a whole, in cod and in saith. Cleithra are also slightly under-represented in ling, if not to such a great degree.

It is tempting to equate this pattern with the removal of cleithra in cured fish, as Colley (1983a:217-228; 1984:127), Cerón-Carrasco (1994:210) and others have done. It is curious, however, that posttemporals, also posterior to the neurocranium and essentially associated with the appendicular skeleton, are much less substantially underestimated. This element is slightly under-represented in the case of Gadidae as a whole and cod. In saith and ling, however, its abundance is consistent with many other Q1 cranial elements.

It is possible, based on this evidence alone, that some or all fish were decapitated between the posttemporals and cleithra. It is equally possible, however, that the cleithra are underestimated due to taphonomic factors. As discussed in Section 8.3.2, cleithra were included as a quantification category one bone partially because of their importance in assessing the cured fish model. This decision was taken despite some evidence that this element is relatively susceptible to destruction by taphonomic processes (see Section 1.3.3 and Figures 7.16-7.18). The other Q1 elements, including the posttemporal, were chosen for their robusticity and species diagnostic features.

To examine the possibility that cleithra are under-represented for taphonomic reasons, all Gadidae cranial and pectoral elements (including Q3 bones) were combined and ordered by rank in Table 8.11. The fragment count of mid-line specimens has been doubled before ranking the data to make comparison with paired elements possible.

The results are instructive. All Q1 elements, excluding the cleithrum, are represented in the top eleven bones. Although the cleithrum (the 17th most abundant element) is under-represented in comparison to these bones, it is actually more abundant than some cranial elements. The sphenotic, ethmoid, otolith, preopercular and other skull elements less abundant than cleithra should all be left at a processing station given the cured fish model.

In order to argue that an under-representation of cleithra *must* indicate the removal of cured fish (as opposed to taphonomic destruction), it would be necessary to argue that bones of the neurocranium such as the sphenotic were cut out of fish heads and also removed (see Figure 1.3). The latter is a very unlikely butchering strategy which one might also expect to have left characteristic cut marks.

This is not to suggest that cleithra could not have been removed with cured fish. It is evident, however, that taphonomic factors *could* explain their under-representation in the same way that it must account for the relative paucity of some cranial elements.

Before leaving this issue it is worth considering the rank of other bones from the pectoral skeleton. All are poorly represented. Two elements, the basipterygium and coracoid, are the least abundant of all identified Gadidae bones. This is not necessarily surprising as they are paper thin and extremely fragile. The scapula, at rank 34 in a list of 39 elements, may require further explanation. It is less obviously ephemeral than the basipterygium and coracoid, but may also be subject to poor preservation. Gadidae scapulae have not survived in trampling (Jones 1991a:102; Nicholson 1991:206) or tumbling (Barrett 1992a:57; Nicholson 1992b:145) experiments. Moreover, they are relatively small bones which might pass through the 4mm sieves more easily than other elements.

Bone size may also play a crucial role in the poor representation of supracleithra. This is a compact element which, by qualitative assessment, one might expect to preserve very well. This assumption is confirmed to some degree by experiment (Barrett 1992a:57; Nicholson 1991:207; 1992b:145; see Table 1.2). However, the narrow cross-section of the 'pen shaped' bone ensures that it will pass easily through 4mm mesh during sieving. Experiments in this regard demonstrate that supracleithra from cod of ≤500-600mm, saith of ≤ 500-600mm and ling of ≤700-800mm total length will pass through the sieves used in lab processing (Table 8.12). An examination of the estimated size distributions of these taxa, Figures 5.26-5.28, illustrates that a very substantial proportion of cod and saith supracleithra from Robert's Haven were probably lost during lab processing.

To summarise this section, the under-representation of appendicular elements at Robert's Haven is consistent with the cured fish model developed in Section 8.2.4 above. It is also possible, however, that the representation of bones such as the cleithrum and supracleithrum is biased by preservation and recovery biases. Further evidence is needed in order to draw firm conclusions.

8.4.3 Vertebrae

As discussed in Section 8.2.4, one might expect some, most or even all vertebrae to be left in cured fish and thus removed from a processing site. Posterior caudal vertebrae are the least likely (and anterior abdominal vertebrae are the most likely) elements to be removed from cured fish. Tables 8.13-8.14 and Figure 8.5 illustrate the relative abundance of two cranial elements (dentaries and premaxillae) and eight different sections of the vertebral column for the most common Gadidae taxa (see Section 8.3.2). Data from both greater and less than 4mm sieve fractions are combined to reduce the effect of recovery on results. This issue is of considerable importance given the decrease in vertebrae size along the length of a fish. Poor recovery would simulate removal of the smaller caudal vertebrae in cured fish (see below).

Table 8.13 illustrates the vertebrae fragment count data in an unmodified form. In Table 8.14, the sum for each vertebral group is divided by the number per fish. This approach facilitates a direct comparison of the abundance of each group of vertebrae, both within the vertebral column and in relation to the two cranial elements. In the case of combined taxa, such as Gadidae and *Gadus/Pollachius*, this procedure produces a range of values rather than a single statistic. This effect is due to inter-taxon variability in the number of bones in each vertebral group (see Table 8.2). While these ranges make statistical analysis of the data untenable, the results can be graphed to facilitate qualitative interpretation.

In Figure 8.5 the ranges illustrated for dentaries and premaxillae represent the difference in fragment count between left and right elements. The few specimens which could not be sided are divided evenly between left and right. As just explained regarding Table 8.14, the range illustrated for vertebrae reflects inter-taxon variability in the number of bones in each vertebral group.

Several patterns, possibly differing among taxa, are immediately evident from these data. In cod, saith and pollack (*Gadus/Pollachius*) the abundance of abdominal vertebrae and the most anterior caudal vertebrae is within or close to the range exhibited by the cranial elements. This observation is particularly striking given that dentaries and premaxillae are among the best preserved cranial elements (see Table 8.11). Conversely, the abundance of caudal vertebrae group two (CV2) may be slightly depressed and the penultimate and ultimate vertebrae are severely under-represented. Only 30 of the former and 22 of the latter were identified. Moreover, Figure 8.5c, which illustrates the data for all cod family taxa combined, indicates that this pattern is not simply a product of identification problems. There are only 56 penultimate and 34 ultimate vertebrae represented in the entire Gadidae assemblage.

It is possible that the relative absence of these two bones, the smallest vertebrae in a gadoid fish, represents recovery bias. Results from the probable domestic assemblage at Earl's Bu - where several lines of evidence suggest the *importation* of cured fish but posterior caudal vertebrae are also missing (see Section 8.5) - supports this interpretation. Given the sorting of all vertebrae to 1mm, however, this pattern could *partially* relate to fish processing methods. Laboratory experiments demonstrate that modern specimens from cod (two reference skeletons available) and saith (two skeletons available) of 300mm total length will not pass through a 1mm sieve despite prolonged vigorous shaking. Given the estimated size distribution of the cod and saith represented at Robert's Haven (see Figures 5.26-5.27) the paucity of penultimate and ultimate vertebrae may not be entirely a factor of recovery bias.

In sum, it is *possible* that these data indicate the removal of ultimate vertebrae, penultimate vertebrae and perhaps some posterior elements of caudal vertebrae group two (CV2) from Robert's Haven in cured cod, saith and/or pollack. All other vertebrae are present in numbers consistent with cranial elements and were presumably discarded during fish processing. Although complicated by the issue of recovery bias, this pattern does match the model developed in Section 8.2.4.

Ling exhibit a different pattern, with all vertebrae but the first underestimated in relation to dentaries and premaxillae (Figure 8.5b). This pattern is tantalizing, but the sample size of ling bones is too small to engender confidence in firm conclusions. It is *possible* that some ling were removed from Area A with the majority of their vertebrae still in situ. This issue will be discussed again below.

8.4.4 Articulated Bones

During excavation of Area A, 207 articulations (clusters of bones, fin rays or scales remaining in anatomical alignment) were recovered. All but eight of these were collected from Columns A, B and C. The remainder were recovered adjacent to the columns during surface cleaning which proceeded excavation. These elements were bagged, labeled and analysed as groups prior to being combined with the primary fish bone assemblage.

The articulations fall into four broad categories. Nine examples (from seven stratigraphic contexts) represent parts of the cranium. Four of these, however, involve elements articulated by the interdigitation of bone processes (such as the ceratohyal and epihyal or parasphenoid and basioccipital). Given their durable bonds, these groups reveal essentially the same information as isolated cranial elements. The other five cranial articulations are indicative of little post-depositional disturbance. They include elements joined only by soft tissue such as branchiostegal rays (4 examples) and dentaries (1 example). Eight of the nine cranial articulations were from cod, while one could only be identified to the family Gadidae.

Four groups of scales (from 4 contexts) comprise the second category. Adequate reference material was not available to identify these articulations definitively, but three of the four compare favourably with saith. The fourth group may also come from a fish of the cod family, but comparison with other taxa would be advisable. As it is not possible to ascertain the anatomical location of these scales, they yield no information regarding fish processing. They do support the suggestion that post-depositional disturbance of the midden must have been modest in scale.

The third category includes 20 examples of articulated fin rays (from 9 contexts). Two groups were missing their diagnostic proximal ends and could not be identified. A further three were ambiguous due to poor preservation, but probably derived from caudal fins. The remainder could be confidently ascribed to the family Gadidae. Seven examples were positively identified as caudal fins, three as dorsal or anal fins, three as left pectoral fins and two as right pectoral fins. While these fins confirm the preservation characteristics of Area A, the sample size is too small to draw firm conclusions regarding the character of fish processing. Nevertheless, the 10 probable caudal fins are curious if fish were removed from the site with their ultimate vertebrae (to which these fins are articulated) left in situ (see above). Moreover, one might also expect pectoral, dorsal and anal fins to be removed with cured fish given the model developed in Section 8.2.4. Like the under-representation of cleithra and posterior caudal vertebrae, this evidence is ambiguous. The small group of 20 fins could derive from a few fish which were spoiled or intended for local consumption. Alternatively, they could imply that cured fish (at least as defined above) were not made at all.

The vast majority of articulations, 174 examples (from 23 contexts), were sections of vertebral column (see Plate 8.13). Contrary to the practice for single vertebrae, an attempt was made to identify every group to species (including the differentiation of cod, saith and pollack). In total, 88 cod, four pollack, 32 saith, two haddock, four torsk, 33 ling, eight other Gadidae (including combined taxa such as Pollachius and Gadus/Pollachius), one hake and two gurnard (probably *Eutrigla gurnardus*) vertebral articulations were recovered.

On initial discovery of articulations in the Area A erosion face, the observation of several clusters of anterior abdominal vertebrae suggested two possibilities. First, it was tempting to think that the articulated vertebrae 'fossilised' fish processing waste precisely as it had been discarded. Second, it was tempting to equate the clusters with a processing method like that described by Low (1879[1774]:137) in which "only the three upper joints of the back-bone are cut out." Predictably, these preliminary hypotheses were proven naive by subsequent excavation and analysis. With a few possible exceptions (see below), the surviving articulations are almost certainly a stage removed from the sections of vertebral column originally cut or pulled from fish during processing. Articulations represent a variety of positions within the vertebral column and include from only two or three to more than ten bones (Table 8.15).

Despite this complexity, the articulations do reveal illuminating patterns. Figures 8.6-8.8 illustrate the vertebral groups represented by cod, saith and ling articulations (the three taxa for which reasonable sample sizes were recovered). The clearest pattern emerges from the cod data. First, no groups of vertebrae are articulated to the cranium (the basioccipital), suggesting that fish were decapitated prior to removal of vertebrae. Second, all vertebral groups are linked to adjacent sections of the back bone by three or more articulations - with the single exception of caudal vertebrae group two. Not a single articulation includes both CV2 elements and more anterior vertebrae. Moreover, caudal vertebrae group two was represented by only six articulations (7% of the total), compared to 39 for CV1. This difference is particularly striking in light of the fact that there are fewer CV1 elements (c.14) per cod than there are CV2 (c.17). In sum, this evidence strongly supports the interpretation tentatively suggested on the basis of the relative representation of all *Gadus/Pollachius* vertebrae (Figure 8.5a). Anterior vertebrae were probably removed from fish during processing (perhaps as a single strip which subsequently became partially or completely disarticulated) leaving the most posterior caudal vertebrae in a product removed from Area A.

A similar, if slightly different pattern emerges from study of the saith data. It is difficult to interpret the significance of a single articulation which includes a basioccipital. It is possible that heads and vertebrae were removed as a single unit in at least some cases. As this articulation only includes the basioccipital and first vertebrae, however, it is more likely that it represents a discarded head.

The most striking differences between cod and saith relate to the caudal vertebrae. In saith, caudal vertebrae groups one and two are represented by the same number of articulations (six). Moreover, two articulations link the groups. It would seem that some or all bones from caudal vertebrae group two were removed along with more anterior elements during the processing of saith. I will return to this issue below.

Ling are different again. Three articulations begin with the basioccipital. One includes only the first vertebrae, one extends into AV1 and one continues into AV2. As suggested regarding saith, these data could imply that heads and vertebrae were removed as a unit. It is also possible, however, that ling were sometimes decapitated further along the length of the fish than cod and (possibly) saith.

The remaining ling evidence is similar to the pattern for cod. Only one out of 33 articulated clusters includes caudal vertebrae group two. It seems likely that these posterior vertebrae usually remained in processed fish. It would be unwise to draw conclusions from a single example, but it is possible that the single articulation including CV2 elements represents the vertebral portion of a discarded cured fish.

8.4.5 Cut Marks

In total, 215 Gadidae specimens exhibited clearly identifiable butchery marks (distinct grooves, most with v-shaped cross-sections). A selection of these cuts are illustrated in Plates 8.14 to 8.21. A further 55 specimens had less distinct groves or scratches which may also have resulted from butchery. As these marks could not be attributed a cultural origin with certainty, they are omitted from the present analysis.

The cut marks fall into six broad categories on the basis of fish anatomy and inferred butchering processes. They are summarised in Figures 8.9-8.12 and Tables 8.16-8.21.

Category one includes a few cut marks on jaw bones: maxillae, premaxillae and a dentary (Table 8.16). The second category entails cuts on bones of the hyoid region: ceratohyals and interhyals (Table 8.17). A third category includes transverse cuts on bones at the junction of the cranial, appendicular and caudal skeleton: supraoccipitals, posttemporals, supracleithra, cleithra, exoccipitals, basioccipitals, first vertebrae and abdominal vertebrae group one (Table 8.18). The fourth group is a small selection of marks, largely in the sagittal plane, on the ventral surface of abdominal vertebrae (Table 8.19). The fifth group consists of cut marks on abdominal and (some) caudal vertebrae which are consistent with splitting a fish axially by passing a knife in the sagittal plane between the vertebral column and the tail musculature (Table 8.20). The sixth, and final, category of butchering marks includes transverse cuts on AV3, CV1 and CV2 which suggest that vertebral columns were severed approximately halfway or more along the tail of the fish from which they came (Table 8.21).

The first and second categories are represented by only five and four specimens respectively. Cuts are found on the jaw bones of one unidentified gadoid, two cod, one saith and one ling. The identified specimens are comparable in size to analogous elements from fish of greater than 800mm total length. These cuts could derive from hook removal or from the extraction of fish tongues for food.

The marked ceratohyals and interhyals of the second category could also derive from the removal of fish tongues. The latter can be cut out through the gill slits. It is also possible, however, that these cod and ling bones (all from fish between 500 and 1000mm in total length) were cut during gutting. This process sometimes involves passing a knife from the anus forward to the anterior limit of the gills. Finally, these bones could also have been cut during removal of fish 'cheeks', a small portion of flesh in the hyoid region.

The third category of cut marked bones is represented by 78 specimens (from 27 stratigraphic contexts). All exhibit evidence consistent with decapitation by passing a blade in the transverse plane between the cranium, the vertebral column and (in at least some cases) the appendicular skeleton. Cod, ling and saith ranging from c.150mm to greater than 1000mm in total length are all well represented. A few specimens from pollack also occur.

The supraoccipital, exoccipital and 14 of 16 posttemporals are cut on the dorsal aspect. However, dorsal, ventral, lateral and (occasional) medial cuts are all represented on supracleithra, cleithra, basioccipitals, first vertebrae and abdominal vertebrae group one (see Plates 8.14 to 8.16). Moreover, seven specimens were recorded with both dorsal and ventral, ventral and lateral, lateral and medial or left and right lateral cuts. It would appear that several cuts (from above, below or the side) were sometimes used to decapitate the fish processed at Robert's Haven.

Cuts on posttemporals, supracleithra and supraoccipitals could be interpreted as evidence that more posterior appendicular elements such as cleithra were left in processed fish. This is supported by the fact that only one of 16 cut cleithra exhibited butchery marks on the posterior margin. Of the remainder, five were cut laterally and (most significantly) 10 were cut on the anterior margin (see Plate 8.5).

It *may* be significant that the single cleithrum cut on the posterior edge is from a ling. Ling cleithra are not as heavily under-represented as analogous bones from cod and saith (see Table 8.10). It is possible that this taxon was sometimes decapitated behind the pectoral skeleton. This pattern would be consistent with the evidence from ling articulations, four of which probably derived from fish decapitated posterior to the first vertebra (see Section 8.4.4). It is unwise, however, to place too much weight on the evidence of a single cleithrum.

Little additional information is provided from the vertebrae exhibiting category three cut marks. They occur on both first vertebrae and abdominal vertebrae group one, with no clear variation between fish of different taxon and size. They are more frequent on first vertebrae (a single element for which there are 14 cut examples) than on AV1 (a group of four elements for which there are only eight cut examples).

Category four is represented by only four cut specimens . One cod, one saith and two ling abdominal vertebrae (all from fish of greater than 800mm total length) exhibit butchery marks on the ventral surface. All of these cuts are in the sagittal plane and are best explained as evidence of gutting.

A total of 97 specimens (from 21 stratigraphic contexts) exhibit cut marks of the fifth category. These marks occur on abdominal vertebrae, on caudal vertebrae group one and (in a very few instances) on caudal vertebrae group two. They cluster in four locations and are all caused by a blade moving more or less in the sagittal plane. These marks make up the majority illustrated in Figures 8.10-8.12.

On abdominal vertebrae, including one first vertebra, category five cut marks cluster around the neural arch - 23 examples are on the arch itself or the adjacent centrum - and the transverse processes - 21 examples are near or on the processes (see Figures 8.10-8.12 and Plates 8.17-8.18). These marks are occasionally more distal, falling on the neural spine or far along the transverse processes. A few cuts on abdominal vertebrae are more proximal, occurring on the edges of the articular facets of centra (see Figures 8.10-8.11).

All category five marks on abdominal vertebrae (for which the relevant data could be collected) were made by a blade moving dorso-ventrally. Of the vertebrae cut near the neural arch, 14 were marked by a knife moving from ventral to dorsal, one was marked by a blade traveling from dorsal to ventral and seven exhibited marks for which no direction could be determined. The opposite pattern applies to the specimens cut near or on the transverse processes. Fifteen were caused by cutting from dorsal to ventral, four by cutting from ventral to dorsal, and two could not be interpreted. Of the five specimens with cut centra, four were cut from ventral and one from dorsal. It is also interesting to note that all sixteen specimens cut from a dorsal direction were marked on the left side. Conversely, ventrally inflicted cuts occur on both sides of the vertebrae (nine left and 13 right).

Category five cut marks on abdominal vertebrae suggest a butchering step in which the lateral musculature of fish was separated from anterior vertebrae by passing a knife along the spinal column. Given the directions from which the marks were inflicted, the blade must have cut from ventral to dorsal or vice versa rather than from anterior to posterior. It is interesting to note that this butchery step was sometimes accomplished by cutting upwards (from ventral to dorsal) on the right side of the fish and downwards (from dorsal to ventral) on the left side.

Caudal vertebrae groups one and two are very unequally affected by category five butchery marks. Cuts occur on 48 CV1 bones, whereas only four CV2 specimens are marked (despite their greater abundance in the dominant taxa cod and saith). It would be reasonable to conclude that a knife was seldom passed beyond the anterior caudal vertebrae. This suggestion is considered in more detail below.

This difference aside, the butchery evidence on all caudal vertebrae falls into two main patterns. First, 33 specimens exhibit cuts similar to those on abdominal vertebrae. These cluster around the neural and haemal arches and at the margin of the articular facets (see Figures 8.10-8.12). On caudal vertebrae, however, virtually all were made by a blade moving from ventral to dorsal, from anterior to posterior, or a combination of the two. The only dorsal cuts occur on a single haemal arch and a single neural arch.

A further 14 specimens exhibit lateral marks on centra indicative of a blade moving from anterior to posterior (see Plate 8.19). In these cases a knife was held either vertically (five specimens), or angled slightly so that cuts were made from both an anterior and ventral direction (nine specimens). An additional five centra (with marks made from a more ventral direction) may have been cut during the same procedure, but with the blade more sharply angled. Three caudal centra exhibit anomalous butchery marks - two were made by a knife moving from posterior to anterior while the third was cut on the dorsal aspect.

The category five cuts on caudal vertebrae are generally consistent with the pattern of fish butchering suggested above - with an added observation that the knife was moved from anterior to posterior, rather than dorso-ventrally, once it reached the caudal vertebrae. It is also evident that vertebrae were seldom cut beyond CV1.

The final, and most important, category of cut marks are found on 27 specimens (from 16 stratigraphic contexts). They were caused by a blade moving in the transverse plane which cut into, but not through, vertebrae of abdominal group three, caudal group one or (rarely) caudal group two (see Plates 8.20 and 8.21). It seems likely that these cuts indicate the point to which vertebral columns were removed during fish processing. After a knife was used to split the fish (separating vertebrae from the tail musculature), it must have been turned 90° (into the fish) and pressed against the vertebral column. As the bones were not cut through, the freed anterior portion of the spine was presumably bent or twisted to separate it from posterior vertebrae which remained in the finished product. The blades which caused the transverse cut marks may have served to hold the processed fish securely against a working surface while anterior vertebrae were removed. It is also possible that these marks were caused by cutting through any remaining soft tissue around the vertebrae to facilitate breakage of the spine.

This category of butchery mark occurs on bones of abdominal vertebrae group 3 and caudal vertebrae group one from cod, saith and ling. It is only in saith, however, that it also occurs on caudal vertebrae group two (two specimens). Although two specimens are meaningless on their own, they may compliment evidence from other cut marks and the articulated bone clusters. Of the five category five cut marks which occur on CV2 elements, four were from saith (Table 8.20). Moreover, CV2 and CV1 elements were both well represented among the saith articulations (Figure 8.7). The sample size is too small to justify firm conclusions, but it is possible that more vertebrae were removed from saith during processing than from cod and ling.

In summation, the cut mark evidence confirms butchery patterns less certain from relative representation of elements data. It is evident that fish were decapitated at Robert's Haven, that anterior vertebrae were cut out, and that some posterior caudal vertebrae were left in the finished products. Moreover, the location of category three cut marks suggests that fish were usually decapitated anterior to the appendicular skeleton - bones such as the cleithrum were presumably also left in the finished products. This pattern is perfectly consistent with the butchery strategy known to have been used for fish traded from medieval and post-medieval Scandinavia (Section 8.2.4).

8.4.6 Discussion

Although some evidence was ambiguous, the overall result of this investigation suggests that cod, saith and ling were processed in a manner consistent with the model of cured fish production outlined in Section 8.2.4. The relative representation of elements data suggest that cleithra and other appendicular bones may be under-represented. More importantly, transverse cut marks on 16 posttemporals, 19 supracleithra, a single supraoccipital and 18 cleithra suggest that all three taxa were often decapitated anterior to the latter element. It is also possible, however, that some ling were beheaded posterior to the appendicular skeleton. This tentative conclusion is based on a single cleithrum with posterior cut marks and on four articulations which include both a skull element (the basioccipital) and anterior vertebrae.

After decapitation, abdominal and (sometimes) anterior caudal vertebrae were separated from the lateral musculature of each fish by passing a knife along the spinal column. This process left butchery marks in the sagittal plane on abdominal and anterior caudal vertebrae. At some point between abdominal vertebrae group three and caudal vertebrae group two a blade was turned perpendicular to the axis of each fish and pressed against the spine, leaving transverse cuts on centra, neural arches and haemal arches. Anterior vertebrae were then separated from the finished product, probably by bending or twisting, and discarded to become articulations. There is some evidence to suggest that this separation occurred closest to the caudal fin in saith, for which more CV2 specimens are represented among the articulated and cut marked bones.

Some CV1 and many CV2 elements must have remained in the resulting fish products, as possibly corroborated by the slight under-representation of CV2 in Figure 8.5. Ultimate and penultimate vertebrae were probably virtually always left in the finished products. It must be noted, however, that this line of evidence may be subject to recovery bias. Posterior caudal vertebrae are tiny and are also under-represented in the presumed fish *consumption* rubbish from Earl's Bu (see Section 8.5).

As a final note, cut marks occur on specimens from a wide range of fish sizes (Figure 8.13). There is a trend towards fish 500mm or greater in total length which is consistent with the size of cod and ling represented in the midden as a whole. It may be relevant, however, that there are few butchery marks on the abundant bones of smaller saith. The butchery data discussed above are exclusively from the >4mm sample, but *no* cut marks were observed on bones from the <4mm fraction. Perhaps, as Bigelow (1985:121) has suggested in the context of Sandwick, Shetland, these fish were often used for immediate local consumption. The evidence of burnt bones, discussed above, suggests that both small and large gadids were eaten at Robert's Haven. Nevertheless, it is possible that only larger fish were routinely butchered for curing (and possible subsequent export). Presumably small saith were cooked whole, or processed for local use in a way which left few cut marks. It is also possible, however, that small fish simply did not need to be split prior to drying for (possible) export (e.g. Plate 8.4).

8.5 A Comparison with Results from Earl's Bu

8.5.1 Introduction

Zooarchaeological results from Earl's Bu provide a useful contrast to Robert's Haven. As a presumed consumption midden, rather than processing area, this site can serve two purposes in the context of the present investigation. Firstly, differences in the relative representation of elements in the two assemblages can suggest whether some patterns observed at Robert's Haven are likely to be taphonomic or behavioural in origin. For example, the abundance of cleithra at Earl's Bu may serve to illustrate whether the paucity of this element at Robert's Haven is a preservation bias. Secondly, the evidence from Earl's Bu may suggest whether cured fish removed from sites such as Robert's Haven were consumed at nearby settlements.

8.5.2 Taxonomic Results

Taxonomic results from Earl's Bu have been included in the synthesis of Late Norse economy presented in Chapter 5 below. However, a more detailed breakdown of the data - including specimens from samples for which information regarding mammal and bird bone was not available - is presented in Tables 8.22 to 8.23. Cod family (and closely related hake family) fishes constitute 99.4% of the >4mm sample fraction (based on quantification category one elements). Within these dominant families, cod (39.1%) and haddock (22.4%) are by far the most important, with saith (3.3%) and ling (2.1%) a distant third and fourth.* As mentioned in Sections 5.6 and 7.2, a superficial examination of these statistics might lead one to believe that the proportion of haddock has been substantially increased by differential preservation. Several haddock elements, particularly the cleithrum and posttemporal, are extremely robust and this taxon is comparatively rare at all other Viking Age and Late Norse sites in the earldoms (see Table 5.6). However, a breakdown of the nine elements identified to species illustrates that haddock is the second most abundant taxon even when anomalous elements such as the cleithrum and posttemporal (which *are* more numerous than other bones from this species) are ignored (see Table 8.24).

The bimodal size distribution of cod, by far the most abundant species, is consistent with that found at other earldom assemblages (Figure 5.29). As discussed in Section 5.6, it may represent shore and boat based fisheries. At least the smaller fish of this species could probably have been caught nearby in Scapa Flow (see Figure 1.2a). Large cod are *sometimes* found in more oceanic environments today, but it is not unreasonable to suggest that they too might have been caught in Scapa Flow (see Section 2.5). Conversely, haddock occupy deep waters on a more consistent basis. It is possible that they were caught at a greater distance from the site, perhaps west of Orkney or in the Pentland Firth (see Colley 1983a:385, 387; Figure 2.5).

The possibility that some fish consumed at Earl's Bu were not caught in nearby Scapa Flow may be corroborated by the relative absence of saith. The latter - typically the second most abundant taxon in Viking Age and Late Norse assemblages from the earldoms - has been an extremely abundant catch in Scapa Flow in the past (Low 1813:193; see Section 5.6). The absence of this species at Earl's Bu may imply that fishing was often carried out elsewhere, with haddock (and perhaps cod) brought to the site from a considerable distance. This interpretation is not entirely inconsistent with the association of Earl's Bu with elite settlement (see below).

* Note that definite and probable identifications are combined here.

These taxonomic results, based on the >4mm sample fraction, are slightly biased by recovery factors. If only elements sorted from both the greater than and less than 4mm fractions are considered, non-Gadidae taxa rise to between 1.8% and 4.3% of the assemblage (based on premaxillae and vertebrae respectively) (see Table 8.23). The most numerous of these are eels (2.7% based on vertebrae) and salmonids (0.4% based on vertebrae). The existence of small scale (probably fresh water) fisheries for these two taxonomic groups has been discussed in Section 5.6 below.

8.5.3 Cranial and Appendicular Elements

The relative abundance of the nine cranial and appendicular elements identified to species is presented in Table 8.24. Haddock cleithra are exceptionally abundant, but this is to be expected given their anomalous preservation characteristics (see Section 1.3.3). Cod cleithra appear to be under-represented, but this is largely a product of identification bias. Many cleithra could only be identified to the categories *?Gadus morhua* or Gadidae. If all gadoid taxa are combined - excluding the anomalous haddock - it is evident that cleithra are actually more abundant than many cranial elements of quantification category one. Some of these bones, such as the quadrate, articular and dentary, are particularly robust elements which were more common than cleithra at Robert's Haven. If all cranial and appendicular elements from quantification categories one and three are combined, the cleithrum is actually the most abundant bone (if haddock is included) or the fourth most abundant bone (excluding haddock) (see Tables 8.25-8.26). This contrasts with Robert's Haven where it was the least abundant of the Q1 elements and the 17th most abundant of the Q1 and Q3 elements combined (see Table 8.11). It is also notable that the supracleithrum - another appendicular element poorly represented at Robert's Haven - is abundant at Earl's Bu. This pattern is particularly important given the potential vulnerability of supracleithra to recover bias (see Section 8.4.2).

This result can be interpreted in three possible ways. Firstly, it could suggest that appendicular elements were indeed removed from Area A at Robert's Haven as suggested above. If their paucity was a product of differential survival they should be less abundant at Earl's Bu where the bone assemblage was less well preserved (see Section 7.7). Conversely, it could imply that large numbers of appendicular elements such as cleithra and supracleithra were brought into Earl's Bu, perhaps in a product resembling that potentially made at Robert's Haven. Thirdly, a combination of these two factors is entirely possible. Given the distribution of cod saith or pollack vertebrae at Earl's Bu (see below), which suggests that both whole and decapitated fish were transported to the site, the last interpretation is probably the most appropriate.

8.5.4 Vertebrae

A consideration of the relative abundance of different groups of vertebrae can shed further light on these interpretations. Table 8.27 summarises the number of vertebrae recovered for the primary gadoid taxa represented in the Earl's Bu assemblage. The greater than and less than 4mm sample fractions have been combined to minimise recovery biases (see Section 8.4.3). In Table 8.28 these data are collapsed into comparable taxonomic categories and the number of specimens from each vertebral group has been divided by the number per fish to facilitate interpretation of their relative abundance. As discussed in Section 8.4.3, this procedure creates a range of values for grouped taxa due to inter-species differences in the number of vertebrae. The two Q1 cranial elements consistently sorted from both sample fractions, dentaries and premaxillae, are also included in Table 8.28. The inclusion of these elements facilitates comparison of the relative representation of fish tails and heads.

When the data from Table 8.28 are presented graphically (Figure 8.15) striking patterns emerge for both haddock and *Gadus/Pollachius* (cod saith or pollack, most of which will be cod based on elements identified to species). Haddock skull elements are under-represented compared to all tail elements except the penultimate and ultimate vertebrae. Although the sample size for Haddock is modest, it is tempting to interpret this pattern as evidence for the importation of at least some decapitated fish to the site. Given this pattern, the high proportion of haddock cleithra and posttemporals observed in Tables 8.24 and 8.25 may not be entirely a taphonomic bias. The absence of the two most posterior vertebrae could suggest that caudal fins were removed during primary butchery as well. However, recovery bias is also possible given the tiny size of these elements (see Section 8.4.3).

The pattern for cod, saith or pollack vertebrae is slightly different. At first glance, it appears that only more posterior vertebrae, particularly caudal vertebrae group one, are over-represented *vis-à-vis* skull bones. This pattern, however, is probably an identification bias. Many vertebrae of AV1 could only be identified to the family level. If Gadidae taxa are combined (see Figure 8.15), it is evident that all but the first vertebra and posterior caudal vertebrae are slightly better represented than skull bones. Ignoring caudal vertebrae for the moment, this pattern can probably be interpreted as evidence that a mixture of decapitated and whole fish (many of which were probably cod, which dominate the Q1 assemblage) was transported to the site.

The small number of penultimate and ultimate vertebrae is not consistent with this interpretation. It could suggest that processed cod, saith or pollack were actually removed from Earl's Bu (as at Robert's Haven). However, the abundance of appendicular elements noted in Section 8.5.3 above makes this interpretation unlikely. As discussed regarding haddock, the conclusion that recovery bias plays a major role in the representation of posterior caudal vertebrae (even when sieving is conducted to 1mm) seems the inevitable conclusion.

Although the over-abundance of CV1 elements identified as cod, saith or pollack can be largely dismissed as an identification bias, this pattern is not inconsistent with the importation of modest numbers of cured fish resembling those processed at Robert's Haven. Some cod brought to Earl's Bu may have been missing anterior vertebrae as well as heads. The distribution of *Gadus/Pollachius* vertebrae *could* be a mixed signal including both taphonomic and behavioural information - the latter of which may be obscured by haddock elements in the combined Gadidae data set. This interpretation cannot be justified using the vertebrae data alone. It may be supported, however, by cut mark evidence discussed below.

Combining the evidence so far, it seems likely that many gadoid fish were brought to Earl's Bu in a decapitated state. For haddock, appendicular elements and all vertebrae were probably left in the headless fish. Some cod, saith and pollack (most of which were likely cod) were probably processed in a similar way, some may have had both heads *and* anterior vertebrae removed and some were transported to the site intact. The apparent absence of penultimate and ultimate vertebrae in all taxa makes more sense as a recovery or preservation bias than as an aspect of fish processing.

8.5.5 Cut Marks

Only 34 specimens from Earl's Bu exhibit cut marks (see Figures 8.16-8.17). However, in light of the relative representation of elements data (and butchery evidence from Robert's Haven) they are quite informative. All occur on gadoid taxa - 13 on cod (or ?cod), one on cod, saith or pollack, 12 on haddock, two on ling and five on cod family specimens (see Table 8.29).

Twenty-five butchered specimens belong to category three as defined in Section 8.4.5. They are all elements which have been cut in the transverse plane at the junction of the cranial, appendicular and caudal skeletal regions - probably during decapitation. One is a first vertebra, three are posttemporals, seven are supracleithra and 14 are cleithra. Nine of the latter are cut on the anterior margin suggesting that they were left in processed fish rather than discarded with heads. Of the remaining cleithra, four were cut laterally, one was sharpened at the ventral tip and only one was cut at the posterior margin.

All of the remaining nine specimens are vertebrae. Only one, a saith element of AV3, exhibits a category five cut mark. It is in the sagittal plane and implies that a blade was passed along the vertebral column to separate the lateral muscle mass. The other cut vertebrae include three AV3 and four CV1 specimens. All except one of these bones belong to category six. They are cut in the transverse plane and suggest that the vertebral columns were severed for removal of their anterior portions.

Although few in number, these cut marks are entirely consistent with the transportation of some cured fish - similar to those presumably made at Robert's Haven - to Earl's Bu. Transverse cuts on supracleithra, posttemporals, cleithra and a first vertebrae indicate that fish were decapitated, with the cleithra and other appendicular elements at least occasionally left in the cured product. Most importantly, cuts in the same plane on AV3 and CV1 specimens indicate that anterior abdominal vertebrae were sometimes removed, while more posterior vertebrae presumably remained in the fish brought to Earl's Bu. The disposal of anterior vertebrae off-site would also explain the virtual absence of category five cut marks. These constituted the most abundant evidence of butchery at Robert's Haven, but occur on abdominal and anterior caudal vertebrae which would have been removed from the presumed cured product.

8.5.6 Discussion

In summation, the evidence from Earl's Bu provides several insights of relevance to the interpretation of Robert's Haven and Late Norse fishing in general. Firstly, it would appear that the under-representation of cleithra and other appendicular elements at the latter site was probably a behavioural pattern rather than a taphonomic bias. Secondly, the under-representation of penultimate and ultimate vertebrae is probably a poor indicator of processing methods despite the use of 1mm mesh for recovery. This observation does not affect the interpretation of Robert's Haven - which is also based on evidence from articulated vertebrae and cut marks. It is, however, an important cautionary tale for zooarchaeological analysis of fish bone in general.

Thirdly, haddock were often brought to Earl's Bu in a decapitated state. The anomalously high proportion of this species (coupled with the low proportion of saith) could also suggest that some fish were not caught in nearby Scapa Flow. They may have been transported from locations in the earldoms with easier access to deep water. This suggestion is not inconsistent with the elite associations of the site. Fish do not appear in early records of rent and tax, but earl's would have had access to produce from their estates throughout Orkney, Caithness and Shetland in the Late Norse Period (see Sections 3.5 and 6.3).

Fourthly, it would appear that *some* cured cod, saith or pollack (most of which were probably cod) similar to those made at Robert's Haven were brought to Earl's Bu. This interpretation is suggested by:

1) the excellent representation of appendicular elements,

2) the presence of category three cut marks (indicative of decapitation anterior to the appendicular skeleton),

3) the presence of category six cut marks (implying the removal of anterior vertebrae) and

4) the virtual absence of category five cut marks (which occur on anterior vertebrae which would be left at a processing site).

It may also be relevant that some *Gadus/Pollachius* caudal vertebrae are over-represented. This pattern is complicated, however, by identification biases. Some anterior vertebrae (particularly of AV1) could only be identified to the family level.

The suggestion that fish processed in activity areas such as Area A at Robert's Haven were transported to consumption sites within the earldoms has obvious implications for the interpretation that they served an export trade. The results from Earl's Bu highlight the caveat that fish middens such as Robert's Haven *could have* served purely local subsistence requirements. Nevertheless, it is perfectly reasonable that similar products might be used for both local consumption and export.

8.6 A Reassessment of Previous Faunal Evidence

Having discussed the data from Robert's Haven and Earl's Bu at some length, it is worth returning to evidence from other fish assemblages in the Norse earldoms. Although previous research has been reviewed in Chapters 1 and 7, it remains to compare results from this work with the butchering patterns tentatively identified in the two assemblages just examined. Both relative representation of elements data and cut marks will be considered.

As discussed in Sections 1.3 and 8.4.2 above, relative representation of elements data are seriously complicated by taphonomic and recovery problems. Nevertheless, it is worth reconsidering the available evidence in light of findings from Robert's Haven and Earl's Bu. Detailed quantitative data are available for two Viking Age (Pool phase 7, Brough Road Areas 1 and 2), one Viking Age to Late Norse I (Pool phase 8) and four Late Norse (Freswick, Quoygrew, Tuquoy and St. Boniface) assemblages (see Figures 1.4 to 1.6 and Table 1.3 for both data and references).

To begin with possible fish midden sites - Freswick Links, Quoygrew and St. Boniface - none exhibit patterns which can be confidently equated with results from Robert's Haven or Earl's Bu. In the case of Freswick Links, the data cannot facilitate detailed comparison (Table 1.3). Cod, saith and ling cleithra may be under-represented, which is consistent with the production of cured fish, but vertebrae were not quantified.

The proportion of vertebrae at Quoygrew and St. Boniface is more comparable with Earl's Bu (and thus consumption waste) than with the fish processing area at Robert's Haven (Figures 1.4 and 1.6). They are more abundant than most or all cranial elements. However, cleithra are relatively poorly represented in both assemblages. It is difficult to explain this pattern. Cured fish could have been exported from these sites after most vertebrae had been removed (like some saith at Robert's Haven). It is also conceivable, however, that a mixture of whole and decapitated fish was actually *imported* to the sites (raising the proportion of vertebrae) and the abundance of cleithra has simply been depressed by taphonomic factors. This latter interpretation may be particularly appropriate for Quoygrew, where vertebrae were not over-represented (and cleithra not under-represented) to the degree evident at St. Boniface (compare Figures 1.4 and 1.6). A more conclusive assessment of these assemblages would only be possible if the degree of taphonomic attrition they suffered could be directly compared with results from Robert's Haven and Earl's Bu.

Turning to other assemblages from the earldoms, the pattern of element representation at Late Norse Tuquoy is broadly comparable to that for Quoygrew (Figure 1.4). It may be consistent with the interpretation that a mixture of whole and decapitated fish was transported to the site.

Results from VA1 and VA2-LN1 phases at Pool are slightly different (Figure 1.5). Appendicular elements such as cleithra are well represented in both phases. Caudal vertebrae are under-represented, but this pattern could be due to recovery bias. Little sieving was conducted at Pool and 10mm or 3mm mesh was employed (Nicholson n.d.b:3, 25; see Table 5.1). Although interpretation of this assemblage is complicated by recovery factors, Nicholson's (n.d. b) suggestion that whole fish were brought to Pool may not be unreasonable.

At Brough Road Areas 1 and 2 (a Viking Age assemblage) appendicular elements and vertebrae fall within the range exhibited by cranial elements (Figure 1.4). It is possible that whole fish are represented at this site, but the use of hand collecting and coarse mesh for recovery makes it difficult to draw firm conclusions.

Table 8.32 synthesises the available cut mark data regarding fish bone assemblages of Viking Age or Late Norse date. Virtually all exhibit butchery marks of categories one, two, three and five (as defined in Section 8.4.5). Category four cut marks are rare. Most importantly, the evidence regarding category six - of crucial relevance to the cured fish model - is ambiguous.

Jaw bones (category one) were cut, presumably from tongue or hook removal, at eight of 12 sites ranging in date from VA1 to LN2. Marks on bones of the hyoid region (category two) were similarly ubiquitous, particularly on branchiostegal rays. The absence of marks on this particular element at Robert's Haven and Earl's Bu may have been an analytical oversight. Branchiostegal rays were not identified to species and thus not examined in great detail.

Cuts indicative of decapitation (category three) are found in all 12 assemblages. Moreover, most of these marks occur on the posttemporal and supracleithrum. As discussed above, this may imply that fish were decapitated anterior to the cleithrum. If so, even the earliest assemblage (Pool phase 7) exhibits at least one characteristic consistent with the production of cured fish for export. Most of the assemblages also exhibit superficial cuts to abdominal and unspecified vertebrae, some of which are definitely from the axial splitting of fish. Unlike Robert's Haven, a few vertebrae were even cut *through* along the sagittal plane. Examples of the latter phenomenon occur at Tuquoy (Colley 1983a:233-234), Saevar Howe (Colley 1983c:113) and Pool phase 7 (Nicholson n.d.b:18-19).

Category 4 butchery marks (ventral cuts to abdominal vertebrae probably indicative of gutting) were recorded only at Saevar Howe. Given their rarity at Robert's Haven and Earl's Bu, this virtual absence is not surprising.

Transverse cuts on central vertebrae (category six) - which suggest the removal of anterior vertebrae from fish at Robert's Haven and Earl's Bu - are difficult to identify with confidence in the other Norse assemblages. Butchery marks which could be in the transverse plane are mentioned in reports regarding six sites (excluding Robert's Haven and Earl's Bu, see Table 8.32). In only one case, however, is it made explicit whether these marks were made by a blade moving in the sagittal or transverse plane. This exception is an abdominal vertebrae from Pool (phase 8) cut dorsally in the transverse plane (Nicholson n.d.b.:21-22). Without knowing what abdominal vertebrae group it belongs to, however, it is impossible to know if this specimen was caused by decapitation or by removing anterior vertebrae.

Several authors imply that these marks were made by a blade moving in the sagittal rather than transverse plane. Cerón-Carrasco, Colley, Jones and Nicholson suggest that butchered vertebrae from Pool phases 7 and 8 (Nicholson n.d.b:12, 22), Brough Road Areas 1 and 2 (Colley 1989:255), Freswick (Jones et al. forthcoming b), St. Boniface (Cerón-Carrasco 1994:208-209), Tuquoy (Colley 1983a:233-234; 1988:4) and Quoygrew (Colley 1983a:216) are indicative of 'filleting'. This term typically refers to passing a blade along the vertebral column of a fish. Nevertheless, it is worth considering illustrations of specimens from three of these sites. Figure 8.18 shows vertebrae from Brough Road Areas 1 and 2 (Viking Age), Quoygrew (Late Norse) and Tuquoy (Late Norse) which are cut laterally. These marks may be analogous to category six examples from Robert's Haven (see Figures 8.10-8.12 and Plates 8.20 to 8.21). It is impossible to be certain, however, without knowing the direction from which they were made. If cut from anterior, for example, they could have been produced by a blade moving along the spinal column more or less in the sagittal plane (i.e. category five). Even if these examples *were* produced while removing anterior vertebrae, they are extremely rare. Quantitative data are not available for all assemblages, but Pool (phases 7 and 8), Freswick Links, Tuquoy and Quoygrew all produced only from one to three specimens *possibly* belonging to category six.

The interpretation of these data is complicated by analytical factors. As mentioned above, cut marks were probably not found on branchiostegal rays at Robert's Haven because they were not explicitly looked for (this element was left unidentified). Conversely, all vertebrae were searched for evidence of butchery under oblique light and any suspicious marks examined using a binocular microscope at magnifications of from eight to 30 times. It is possible that many marks went unrecorded in studies where they were not a central component of the investigation. Freswick provides the most salient expression of this possibility. Gadidae vertebrae were not generally identified or even consistently extracted from excavation samples. As discussed in Section 5.3.3, only dentaries, cleithra, premaxillae and otoliths were routinely identified to species (Jones et al. forthcoming a; forthcoming b). It is not surprising, therefore, that only three first vertebrae and a single caudal centrum were noticed to exhibit evidence of butchery.

The butchery evidence from ten comparative assemblages throughout Orkney and Caithness is not conclusive. Fish were probably decapitated anterior to the cleithrum from the early Viking Age to the 14th century, and some were split axially for at least part of their length. It is difficult to say, however, whether anterior vertebrae were removed during fish processing. Only at Robert's Haven and Earl's Bu is evidence for this last pattern secure.

In summation, it is not possible to identify the removal of cured fish from any of the comparative assemblages under consideration. Data from Freswick Links are ambiguous. Fish may have been processed for 'export' at St. Boniface, but other interpretations are also possible. Local use of intact fish (and perhaps the importation of some decapitated fish) is possible at Quoygrew, Tuquoy, Pool and Brough Road Areas 1 and 2. In all cases, however, it is evident that the interpretation of fish butchering practices is complicated by taphonomic biases, recovery biases and analytical strategies intended to collect information different from that of interest in this study. In particular, a comparable measure of taphonomic attrition would be a useful guide for the interpretation of relative representation of elements data.

8.7 Conclusion

The analyses attempted in this chapter suggest that fish processed at Robert's Haven probably resembled those described in late medieval sources, excavated from 11th to 14th century levels at sites such as Schleswig, and illustrated by Olaus Magnus in the 16th century (see Section 8.2.4). Whether the butchered fish were dry salted or simply hung to dry they are consistent with cured products known to have been traded from Scandinavia and Scotland since the Middle Ages. This observation does not prove that fish were exported from Robert's Haven. It does, however, open the *possibility* that they were exported. The confidence with which one can raise this *possible* interpretation to a *probable* interpretation depends on the integration of zooarchaeological, archaeological and historical evidence addressed in Chapters 5 to 8. Chapter 9 represents an attempt to achieve this integration.

In contrast to the pattern at Robert's Haven, whole and cured fish were probably *brought into* the settlement at Earl's Bu. Evidence from this site supports the hypothesis that cured fish were made in the Late Norse Earldoms. It also raises the important caveat that fish processed at sites such as Robert's Haven could have supplied regional demand rather than an export trade. Nevertheless, it is not unlikely that similar products might be used for both local consumption and export.

As found in Chapter 1, evidence regarding fish processing at other Norse sites is currently inconclusive. This observation is necessitated by a combination of taphonomic biases, recovery biases and analytical strategies which were not intended to collect information of relevance to this study. Decapitated (possibly cured) fish *may* have been transported to some sites and others were probably self-supporting. In no case, however, is there conclusive proof of fish processing for export. Data regarding Freswick Links, identified as a fish midden in Chapter 7, does not facilitate firm conclusions. Processing for 'export' may have occurred at St. Boniface, a *possible* fish midden, but taphonomic factors could also explain the under-representation of cleithra in this assemblage. Fish bone from Quoygrew, a third potential fish midden, may actually have derived from local consumption. Detailed data are not available for the Sandwick assemblage, the remaining possible fish midden site considered in Chapter 7.

Chapter 9

Discussion: Towards a Palaeoeconomic Reconstruction of the Norse Earldoms

9.1 Introduction

There were four primary aims of this thesis. Firstly, it was hoped to elucidate the key sources of wealth in the Norse earldoms of Orkney and Caithness and, more specifically, the possible economic role of fish trade. Secondly, it was intended to illuminate how control of these sources of wealth was distributed within Viking Age and Late Norse society. Thirdly, the study was expected to reveal chronological trends in the relative socioeconomic importance of different sources of wealth and the social relations surrounding them. Finally, it was hypothesised that a consideration of all these issues might illuminate the character and causes of the transition of Orkney, Caithness and Shetland from a semi-independent and non-Christian Viking Age polity to a periphery of medieval Christian Europe. In concluding the study, it is possible to illuminate the first two issues with some clarity. It is also possible to provide some insight into the third and fourth goals. However, final resolution of the causes underlying a transition from the Viking Age to the Late Norse Period or 'Middle Ages' remains an important direction for future research.

9.2 Sources of Wealth in the Viking Age and Late Norse Earldoms: The potential role of fish trade.

The considerable wealth of at least the elite of Orkney, Caithness and Shetland in both the Viking Age and Late Norse Period was established in Chapter 4. The evidence for this includes silver hoards, monumental architecture and historical records of rent, tax, tithe and tribute. To borrow the words of Snorri Sturluson, the sources of this wealth "rested on a good many foundations" (Pálsson & Edwards 1976:76). These foundations included both primary and secondary sources. The former were arable agriculture, pastoralism, fishing, fowling, hunting and collecting (a category including the gathering of products such as peat, fodder and shell fish). The latter included piracy, taxation, mercenary activity, shipping tolls, provisioning shipping, piloting and export trade. Not all of these activities, however, were of equal socioeconomic importance.

A synthesis of archaeological, archaeobotanical and zooarchaeological evidence suggests that arable agriculture (particularly the cultivation of oats and barley), pastoralism (intended to produce a variety of meat and secondary products from sheep, cattle and pigs) and fishing (focused primarily on the capture of marine cod family fish) were of fundamental importance at virtually every settlement in the earldoms from the Viking Age to the end of the Late Norse Period. These activities were probably supplemented by small scale fowling (principally of seabirds) and - perhaps only in elite circles - hunting. Collecting provided the materials necessary to conduct these primary subsistence activities - such as seaweed for fertiliser, grass for fodder and shellfish for fish bait.

Subsistence resources could be transformed into greater wealth through exchange or by sustaining labour. Earl's and magnates maintained retinues by feasting them with the products of cultivation and pastoralism - particularly malt (in the form of ale) and meat. These retinues facilitated the acquisition of plunder, traditionally viewed as the sustaining medium of Viking Age elite power (Hedeager 1994; Reuter 1985). They must also have provided a monopoly on the use of violence which facilitated the collection of shipping tolls, taxes and rents - particularly after the quantitative importance of piracy declined in the more stable Late Norse Period (see Chapter 6). At a smaller scale, peasants may have transformed their own labour into greater wealth through (perhaps informal) arrangements for piloting and provisioning passing shipping.

The significance of export trade as a source of wealth can be assumed during both the Viking Age and the Late Norse Period. Imported objects, particularly (but not exclusively) currency, suggest the existence of long range market exchange in the Viking Age. The potential quantitative importance of this trade is highlighted by the Skaill silver hoard which, at over 8kg, is three times larger than any contemporary Norwegian example (Graham-Campbell 1993:180). Contrary to the arguments of Kruse (1993), it is likely that Viking Age silver was intended at least in part for market exchange. Evidence in support of this interpretation includes the use of hacksilver (rather than finished objects), purity checks (nicks) and weight standards. It may also be relevant that silver ingots were manufactured locally (see Section 6.8).

The scale of long range trade must also have been significant in the Late Norse Period. Approximately 482 sherds of imported medieval pottery (or 128 excluding the town of Kirkwall) have been recovered in Orkney, Caithness and Shetland. This quantity compares favourably with the six sherds known from Iceland, another *predominately rural* North Atlantic colony (Sveinbjarnardóttir 1992:155-157).

Historical evidence is first known in the Late Norse Period. Explicit references exist regarding the export of grain from Orkney - in one case by a member of an important 12th to 13th century magnate dynasty (Þorkel Rostung, a nephew of Bishop Bjarni Kolbeinsson) (McGrew 1970:129-130). However, the reliability of this trade may have been limited by the susceptibility of cereals to crop failure in the environments of Orkney, Caithness and particularly Shetland (see Section 6.9.1). There is a slight possibility, based on the recovery of wheat from Late Norse contexts at Freswick Links, Earl's Bu and Robert's Haven, that cereals were sometimes *imported* to the Norse earldoms. Wheat is not grown this far north in Scotland and is otherwise unknown in the archaeobotanical record from Orkney, Caithness and Shetland (see Section 5.4).

Wool, butter and cattle may also have been exported, but the evidence for this pattern is either circumstantial or post-medieval in date. It may be particularly relevant that zooarchaeological evidence does not suggest an intensive focus on the production of secondary animal products. In contrast to Bigelow's (1989:188-189; 1992:19) model based on archaeological data from Sandwick, Shetland, there is little persuasive evidence among the 28 faunal assemblages considered in this study for a shift to intensive dairying in the Late Norse Period (Section 5.5)

Other possible exports were probably of modest quantitative significance or of value for only a limited period of time. Slaves may have been an important medium of exchange early in the Viking Age, but are unlikely to have been a major component of economic life in the more stable centuries of the Late Norse Period (Chapters 4 and 6). Other products, such as feathers, furs and steatite, were probably of minor significance in both the Viking Age and Late Norse Period (Chapter 6).

While evidently important, the sources of wealth discussed hitherto may not entirely account for the considerable wealth of the Viking Age and Late Norse earldoms. Did the export of cured fish play a role in the generation of wealth? In order to elucidate this question it is necessary to consider two key issues. First, were the earldoms engaged in the export of cured fish at all? Second, how was this proposed trade articulated with other socioeconomic patterns such as taxation and the export of cereal products?

An argument in favour of the export of cured fish from Norse Caithness (and possibly Orkney and Shetland) has been developed in Chapters 6 to 8. It rests on eight foundations.

1) Evidence that long range market trade occurred in both the Viking Age and the Late Norse Period. This evidence includes imported products - such as currency, wood, distinctive metalwork, wheel made pottery (in LN2) and possibly wheat - and the historical record (Section 6.8).

2) Analogy with Norway and Iceland where historical evidence records that cured fish were exported from the 11th and 13th centuries respectively (Section 6.9.2).

3) Analogy with 15th century and later records regarding Orkney, Caithness and Shetland which explicitly discuss fish trade (Section 6.9.4).

4) Circumstantial historical evidence dating from the 12th to 14th centuries which could imply that the earldoms were participating in cured fish trade (Section 6.9.3). Two examples are the presence of Orcadians at the English fishing entrepôt of Grimsby in the 12th century (Pálsson & Edwards 1981:109) and the shipment of salt to Caithness in the 14th century (Burnett 1878).

5) A single direct reference to the purchase of 15000 dried fish (*durorum piscium*) from Caithness by the Royal Exchequer of Scotland in 1329 (Stuart & Burnett 1878:239).

6) Zooarchaeological evidence which tentatively suggests that the intensity of fishing implied by Area A at Robert's Haven (13th-14th century in date) is consistent with 18th century *commercial* fishing stations in Shetland. Northmavine, among the largest of the latter, was responsible for a catch of 50000 fish per year (Fenton 1978:573) while Robert's Haven *may* represent a catch of between 10000 and 100000 fish per year. This estimated range is not considered accurate. It should, however, provide some idea of the order of magnitude of fishing at Robert's Haven. Similar (c.13th century) fish midden deposits also exist at Freswick Links (Sections 7.2 and 7.3).

7) Middens which *may be* indicative of equally intense fishing activity exist at other sites in the earldoms: Quoygrew in Orkney, St. Boniface in Orkney and Sandwick in Shetland. In these cases, however, the evidence is complicated by inter-site differences in methods of recovery and analysis (Section 7.2).

8) The use of a fish processing strategy at Robert's Haven which is entirely consistent with the manufacture of cured products known (from historical, pictorial and archaeological evidence) to have been traded in northwestern Europe between the 14th and 16th centuries. Similar processing methods *may* have been used in the earldoms during earlier centuries, but the available zooarchaeological data cannot support this hypothesis (Chapter 8).

Together, this evidence suggests that fish *were* exported from the earldoms (or at least Caithness) by the 13th and/or 14th centuries. It is not certain that precisely the catches processed at Robert's Haven and Freswick Links were destined for export. Zooarchaeological evidence from the settlement site of Earl's Bu, Orkney, suggests that some cured fish were intended for local consumption (Section 8.5). Nevertheless, given the purchase of 15000 dried fish from Caithness in 1329, the distinctive character of these sites is certainly consistent with the production of commodities rather than (or as well as) subsistence resources.

While the export of cured fish in the Late Norse Period 2 is relatively secure, it is not yet possible to pinpoint the *naissance* of this activity. It would be unwise to suggest that trade began in the 13th century on the basis of only two sites. Older fish middens may exist in Orkney, Caithness or Shetland and the virtual absence of earlier historical evidence regarding all aspects of the earldoms is certainly not evidence for the absence of fish trade. As discussed in Section 6.10 above, there is no a priori reason to assume that fish trade began in any particular century within the Viking Age or Late Norse Period. The strongest available evidence is obviously consistent with a 14th century origin, but another *possible* fish midden - phase eight at St. Boniface - probably began to form in the 11th century (Section 7.4; Lowe 1993:30).

9.3 Synchronic Trends: How were sources of wealth distributed and controlled within Late Norse society?

Having established that fish trade occurred, at least towards the end of the study period, it remains to investigate the precise role of such a trade in the economy of Late Norse Orkney, Caithness and Shetland. How might a putative export of cured fish have contributed to the wealth and power of the Late Norse elite? Moreover, what was its position *vis-à-vis* other sources of wealth in the Norse earldoms?

In order to answer this question it is necessary to consider the settlement context of fish middens such as Robert's Haven and Freswick Links. First, settlement at or near Robert's Haven was probably year-round, not seasonal. The size distribution of small fish found in the Area A midden is consistent with specimens caught at a variety of growth stages in their first four years of life. Similar conclusions are justified by the evidence from Freswick Links (Section 7.5).

Second, the fish middens at Robert's Haven, Freswick Links and other possibly similar sites include more than fish bone (Section 7.5). In addition to primary fish processing waste, Area A at Robert's Haven contained a background component of household rubbish. It included a ubiquitous trace component of mammal bone, bird bone, peat ash, burnt peat, unburned peat, monocotyledon leaves (perhaps from animal fodder or bedding), carbonised oats and barley (including chaff and weed seeds suggestive of local processing) and over 1000 fragments of pottery. Moreover, contemporary deposits elsewhere in the archaeological landscape of Robert's Haven were dominated by mammal bone. Evidence for dwellings at the site has been complicated by 20th century quarrying activity, but some record of structures also survives. A building in Area E may date to the Late Norse Period and a medieval chapel once existed within a few hundred meters of the excavated areas. It must also be relevant that Robert's Haven lies in a historically recorded estate, Duncansby, which geological maps reveal as an island of agricultural land in a sea of blanket peat (see Figure 2.3 and Plate 2.1).

If fish were processed for export at Robert's Haven, this activity formed one focus of a permanent settlement with diverse economic interests. This pattern can be paralleled at Freswick Links, and at other *possible* fish midden sites: Quoygrew, Sandwick and St. Boniface. Structural evidence, carbonised vegetation, mammal bone, bird bone and pottery were recovered at Freswick Links in Caithness, Quoygrew in Orkney and Sandwick in Shetland. Pottery and structural remains were not found at St. Boniface, but it (like Robert's Haven, Freswick Links and Sandwick) can be associated with a Late Norse chapel (Section 7.5).

It would appear that fish production for possible trade was conducted in the context of permanently settled farmsteads. What, however, was the niche of these farmsteads in the socio-economic hierarchy of the Late Norse earldoms? Discussion is presently limited to a synchronic perspective focused on the 1200s and 1300s. These centuries, the Late Norse Period 2, are comparatively well served by both archaeological and historical evidence.

Referring to settlement at Sandwick in Shetland, Gerald Bigelow (1985:122-124; 1989:188-191) has suggested that the export of fish - conceivably in exchange for grain - might have provided a means of subsistence for peasant farmers whose agricultural produce was extracted by earls and the church through tax, rent and tithe. This is an intriguing suggestion which I was initially inclined to extrapolate to Orkney and Caithness (Morris et al. 1994:151). It is tempting to interpret fish middens as the deposits of peasants whose agricultural produce was taken to supply the meat and ale of elite feasts described in late 12th or early 13th century sources such as *Orkneyinga Saga* (e.g. Pálsson & Edwards 1981:56, 70, 124, 215). On further study, however, the hypothesis that fish middens were associated with peasant settlements has proven untenable. The inhabitants of Robert's Haven, Freswick Links and other possible fish midden sites had access to exotic wheel made pottery (Table 6.5). Freswick Links has yielded a 13th century English coin and a hoard of over 82 silver sterlings was recovered several hundred metres from Robert's Haven (Tables 6.6 and 6.7). The association of both sites with chapels, presumably proprietary establishments of substantial landholders (see Helle 1988:51), is probably also relevant. Finally, both Duncansby (where Robert's Haven lies) and Freswick Links are estates associated with powerful magnates, particularly Sveinn Ásleifarson, by *Orkneyinga Saga* (Pálsson & Edwards 1981:101, 124, 145, 150-151, 185, 189). In sum, it seems likely that the two convincing 'fish midden' sites were associated with high status settlement.

One argument used to support the suggestion that Robert's Haven and Freswick Links were relatively high status settlements - the interpretation that imported pottery is indicative of wealth - requires some discussion. Small amounts have been recovered from virtually every excavated LN2 site in Orkney, Caithness and Shetland (Table 6.5). The assumption that inhabitants of settlements such Robert's Haven and Freswick Links were relatively wealthy assumes that some segment of society was not. Where then are the low status sites of the earldoms? Where are the households of peasant tenants such as the man ill treated by Árni Spýtuleggr in *Orkneyinga Saga* (Pálsson & Edwards 1981:163)? There are two feasibly solutions to this paradox. First, it is possible that low status settlements have simply not been identified due to the absence of datable imported pottery or metalwork. Second, it is possible that low status inhabitants of the medieval earldoms were attached to the households of *bœndr* (free farmers), magnates or earls as slaves, servants and labourers (see Dennis et al. 1980:125-128, 172-174 for Icelandic analogs). In either case, the virtual absence of settlements without exotic wheel-made pottery does not negate its value as an indicator of at least moderate wealth. The tiny number of sherds in any single site (other than the town of Kirkwall) may actually confirm its role as a rare product with concomitant value. Locally made fibre tempered wares probably constituted the common (low status) pottery of the earldoms (e.g. Batey 1987a:275-280; Batey & Williams 1986; Gaimster 1986; Gaimster & Batey forthcoming).

Returning to the issue at hand, it would appear that Late Norse fish trade may have been controlled by relatively wealthy landholders rather than impoverished peasants. The participation of *magnates* in fish trade forms an interesting contrast with the likely export interests of *earls*. Based on analogy with post-medieval patterns, earls (and perhaps bishops) presumably traded the predominately agricultural products of tax, rent and tithe known from 15th-16th century rentals and a few earlier sources (Section 6.3; see Shaw 1980:165). This possible contrast in economic interests can be illustrated (for the 12th-13th centuries at least) by two anecdotes from *Orkneyinga Saga*. Earl Rǫgnvaldr Kali Kolsson disguised himself as a fisher and recited the verse "Few know an earl, to see him clearly, in fishing clothes" (Bibire 1984:85). Conversely, the magnate Sveinn Ásleifarson, who "*apart from those of higher rank than himself* * ... was the greatest man the western world has ever seen in ancient and

* "er eigi hofðu meira tignarnafn en hann" (Gudmundsson 1965:289)

modern times", was fishing when his father was killed (Pálsson & Edwards 1981:218; emphasis mine).

Although it is important to accept the probability of spatial and chronological variability in economic patterns, these observations provide some justification to speculate on the socioeconomic role of fish trade in the Late Norse earldoms. It may not have contributed directly to the wealth of earls, who could export the agricultural produce of rent and tax rather than fish. Their privileged access to these products was probably ensured by a military retinue retained through a combination of feasting (also on agricultural produce, particularly ale) and the giving of gifts such as precious metals and distinctive metalwork (possibly secured through export trade) (Chapter 6).

Conversely, trade in fish may have provided a social stratum of magnates and other wealthy farmers - perhaps the *bœndr* mentioned by both *Orkneyinga Saga* (e.g. Guðmundsson 1965:299) and a late 13th century Scottish document (Crawford 1985b:26) - with access to imported exotic products with which they could emulate the status of earls. One artifact from Robert's Haven is particularly interesting in this regard. It is a tinned copper alloy spoon or, to offer a speculative interpretation, an imitation of the silver service one might expect in the context of an earldom or royal site (e.g. Dasent 1894b:366-367). By facilitating the acquisition of exotic material culture, an export trade in cured fish may have provided a mechanism by which magnates and other *bœndr* could emulate and perhaps even challenge the status of their putative superiors.

The historical record provides some evidence consistent with this hypothesis. One of the most evocative references to the dialectical relationship between earls and their subjects is provided by Earl Haraldr Maddaðarson's response to King Sverrir Sigurðarson of Norway after the failed rebellion of 1194:

> Less blame is mine in this business than is imputed to me. I did not plan the rising of that band. It is true that I did not fight against it, for I could not be hostile to *all the people in the land* [allan lýð þar í landi] as long as I should be Earl over it. *The men of Orkney* [Orkneyíngar] do not always act as I wish (Sephton 1899:156; emphasis mine; Icelandic from Norræna Fornfræða Fèlags 1834:299).

Regardless of whether these words were ever spoken by Haraldr it is surely relevant that they seemed appropriate to the contemporary composer of *Sverri's Saga* (Sephton 1899:1).

This reference is not, however, an isolated example of the autonomous status of the *bœndr* (particularly south of the Pentland Firth). Their independence also manifested itself in confrontations with ecclesiastical and royal authority. The farmers of Caithness killed Bishop Adam during a dispute over tithes in 1222 (Guðmundsson 1965:298-300). Even as late as 1263 the Scottish crown required hostages to ensure the loyalty of Caithness (Stuart & Burnett 1878:13, 19) and King Hákon of Norway chose to collect tribute rather than troops from the Norse colony (Dasent 1894b:346). It may be reasonable to *speculate* that the acquisition of exotic goods through the export of cured fish provided one mechanism by which this independence was expressed and maintained.

9.4 Diachronic Trends and Directions for Future Research

Trade in cured fish dominated the export economy of Norway throughout the Middle Ages, starting in the 11th or 12th century (Nedkvitne 1976:250; Urbanczyk 1992:132-145). It has been suggested that participation in this trade contributed to the transformation of semi-independent chiefdoms - particularly Arctic Norway - into peripheries of the Medieval state of Norway and into a Christian pan-European economic system (Bertelsen 1991:25-26; Bertelsen 1992; Urbanczyk 1992:230-239). It was originally hoped that this study might reveal whether a similar process occurred in the less well documented Norse earldoms of Scotland. Is it possible that participation in the European stockfish trade was causally linked with an 11th century transition sometimes perceived as dividing the Viking Age from the subsequent Late Norse Period?

Regrettably, present data are insufficient to answer all aspects of this question. The existence of a fundamental 11th century socioeconomic transition *is* probably indisputable (Section 6.10). Pagan graves of 9th and 10th century date gave way to presumed Christian burials with no grave goods (Table 4.1). Moreover, silver hoards - including 'dark age' symbols of elite status such as distinctive ball-type brooches - disappeared in the 11th century (Table 6.6; see Nieke 1993). They were replaced by new expressions of wealth - monumental architecture (often private ecclesiastical foundations such as St. Magnus Cathedral, Kirkwall) in contemporary European styles (Appendix 3.2). As discussed in Section 9.2 above, however, the earliest convincing evidence for export of fish from the earldoms presently dates to the 13th-14th centuries.

Although a Viking Age/Late Norse transition did occur, and fish probably were exported from the earldoms, the chronological connection between these two socioeconomic phenomena remains ambiguous. To help resolve this uncertainty it would be of considerable value to survey eroding coastlines in Orkney, Caithness and Shetland in search of fish middens comparable with those at Robert's Haven and

Freswick Links. If other examples exist, and these deposits *are* associated with fish processing for export, it may be possible to date the beginning of cured fish trade with more confidence.

Before abandoning discussion of chronological patterns altogether, it is worth considering the *possibility* that fish trade did begin with the earliest convincing evidence - in the 13th-14th centuries. This suggestion is not adequately justified on the basis of two sites. Older fish middens may yet be found in the earldoms. Nevertheless, a late 13th or 14th century date does correspond with social and environmental developments of potential relevance to economic patterns in Orkney, Caithness and Shetland.

From the late 12th century, Norwegian royal authority was waxing in the Northern Isles and Caithness was increasingly dominated by Scottish appointees (Section 4.5). Furthermore, the earldoms were ravaged by bubonic plague in 1349 (Storm 1888:224, 275) and possibly concurrently affected by the Little Ice Age (although the date of the latter remains an issue of contention) (see Section 2.6; Hughes & Diaz 1994:136-137; Thomson 1984).

It is not inconceivable that a change in the intensity of fishing activity in northern Scotland was associated with some combination of these phenomena. Environmental deterioration has been identified as a factor of great relevance to economic change in medieval Iceland and Greenland (e.g. Buckland et al. 1994; McGovern 1994; McGovern et al. 1988), and could conceivably have enhanced the importance of fishing *vis-à-vis* agriculture in Orkney, Caithness and Shetland. If so, distinctive fish middens could be interpreted in two ways. They might suggest that fish partially replaced grain as an export commodity. Alternatively, and in contrast to the arguments raised in this thesis, they may simply imply that domestic consumption of fish increased in the face of diminishing agricultural returns.

It is also possible, however, that increased royal control was responsible for introducing the earldoms to pre-existing Norwegian and Scottish patterns of fish trade. The 14th century reference to the purchase of fish in Caithness by the Scottish royal exchequer is certainly consistent with this interpretation (Stuart & Burnett 1878:239). It may also be supported by the presence of Scottish medieval pottery (which could have come either directly from the south or via Bergen in Norway) at both Robert's Haven and Freswick Links (see Table 6.5; Ditchburn 1990:74). By way of analogy, it may be relevant that the focus of Iceland's export economy shifted from wool to cured fish after it became a Norwegian colony late in the 13th century (Gelsinger 1981:181; Urbanczyk 1992:72).

These possibilities are offered as alternative hypotheses for future investigation. Until the origin of fish trade in the earldoms is better dated, it is impossible to suggest whether it could have been associated with:

1) the 11th century Viking Age to Late Norse Period transition,

2) the 13th-14th century waxing of Norwegian and Scottish royal influence,

3) economic stress associated with 14th century phenomena such as the Little Ice Age and the bubonic plague or

4) other unrecorded socioeconomic phenomena.

As suggested above, the identification and dating of further fish middens in the earldoms may help resolve this uncertainty.

9.5 Conclusion

In conclusion, it is possible to make five observations. Firstly, although a multiplicity of sources of wealth may have been available to all strata of Viking Age and Late Norse Society, long range market exchange was probably of considerable socioeconomic importance in both periods. Secondly, historical and archaeological evidence is consistent with the export of cured fish from the earldoms, at least in the 13th-14th centuries. Thirdly, this trade was conducted from settlements of considerable wealth and status, but probably not from sites directly associated with the earls of Orkney and Caithness. It, may have been of particular importance to magnates and *bœndr* (free 'farmers') whose agricultural produce was extracted by earls and the church as tax and tithe. By facilitating the acquisition of exotic material culture, an export trade in cured fish may have provided a mechanism by which independent 'farmers' could emulate and perhaps even challenge the status of their putative superiors.

Fourthly, it is not yet possible to date the beginning of fish trade in the earldoms. Although the best evidence is associated with the 13th-14th centuries, an earlier origin cannot be entirely ruled out. If fish trade did begin in these centuries, its *naissance* may be causally related to concurrent phenomena such as the expansion of Norwegian and Scottish royal power, the Little Ice Age or the bubonic plague. These issues remain interesting directions for future research.

Finally, uncertainty regarding dating makes it impossible to suggest whether fish trade was related to the 11th century transition of Orkney, Caithness and Shetland from a semi-independent and non-Christian Viking Age polity to a periphery of medieval Europe. Patterns recognised by Bertelsen (1992) and Urbanczyk (1992) in Arctic Norway cannot be extrapolated to the Norse earldoms of Scotland on the basis of present evidence. Future research, intended to identify and date further fish middens in northern Scotland, may help resolve these issues of chronology.

"Few Know an Earl in Fishing-clothes"

Fish Middens and the Economy of the Viking Age and Late Norse Earldoms of Orkney and Caithness, Northern Scotland

Volume II

James Harold Barrett

Ph.D.

University of Glasgow

Department of Archaeology

December 1995

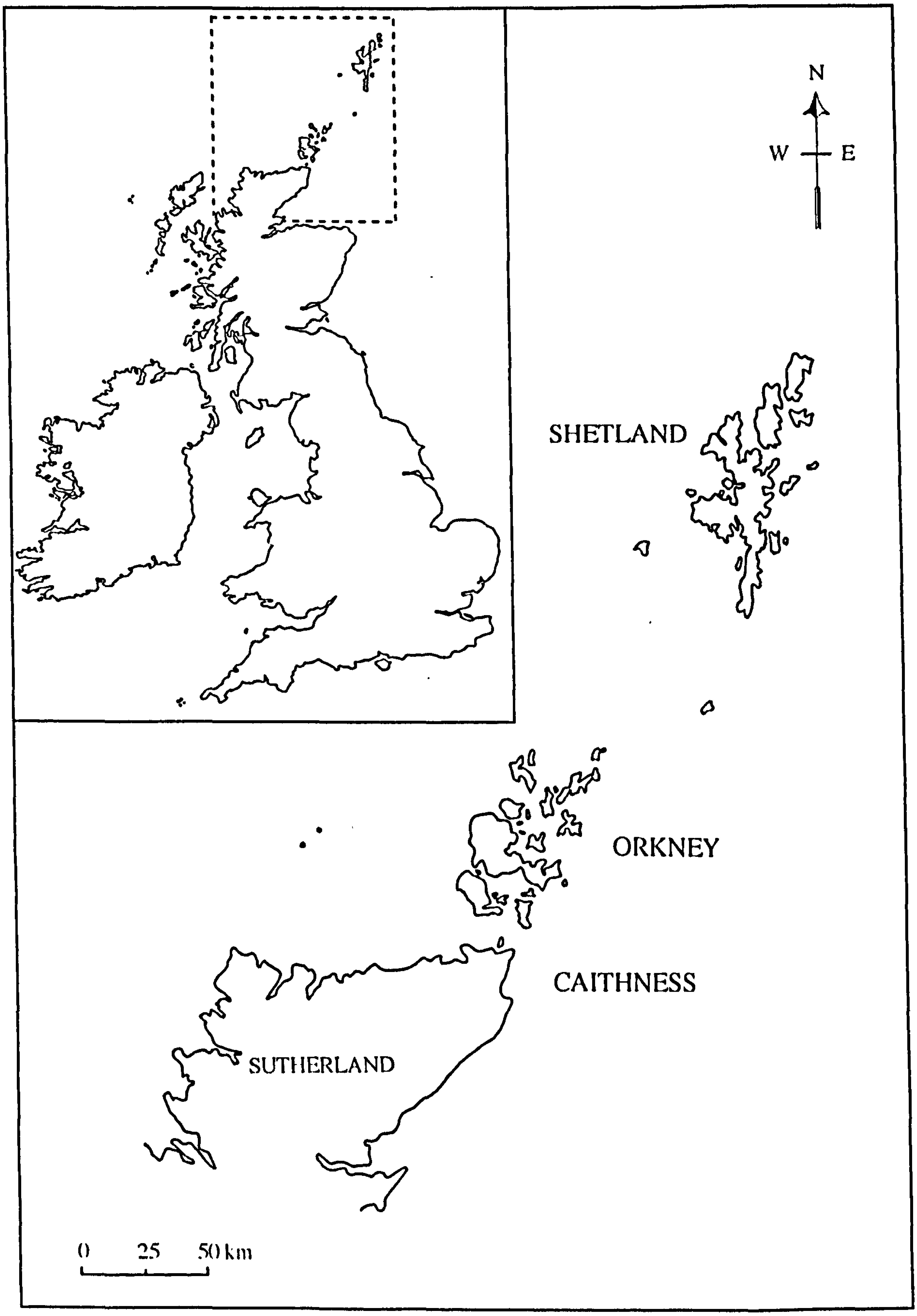


Figure 1.1. The Study Boundaries: Orkney, Caithness (including Sutherland) and Shetland

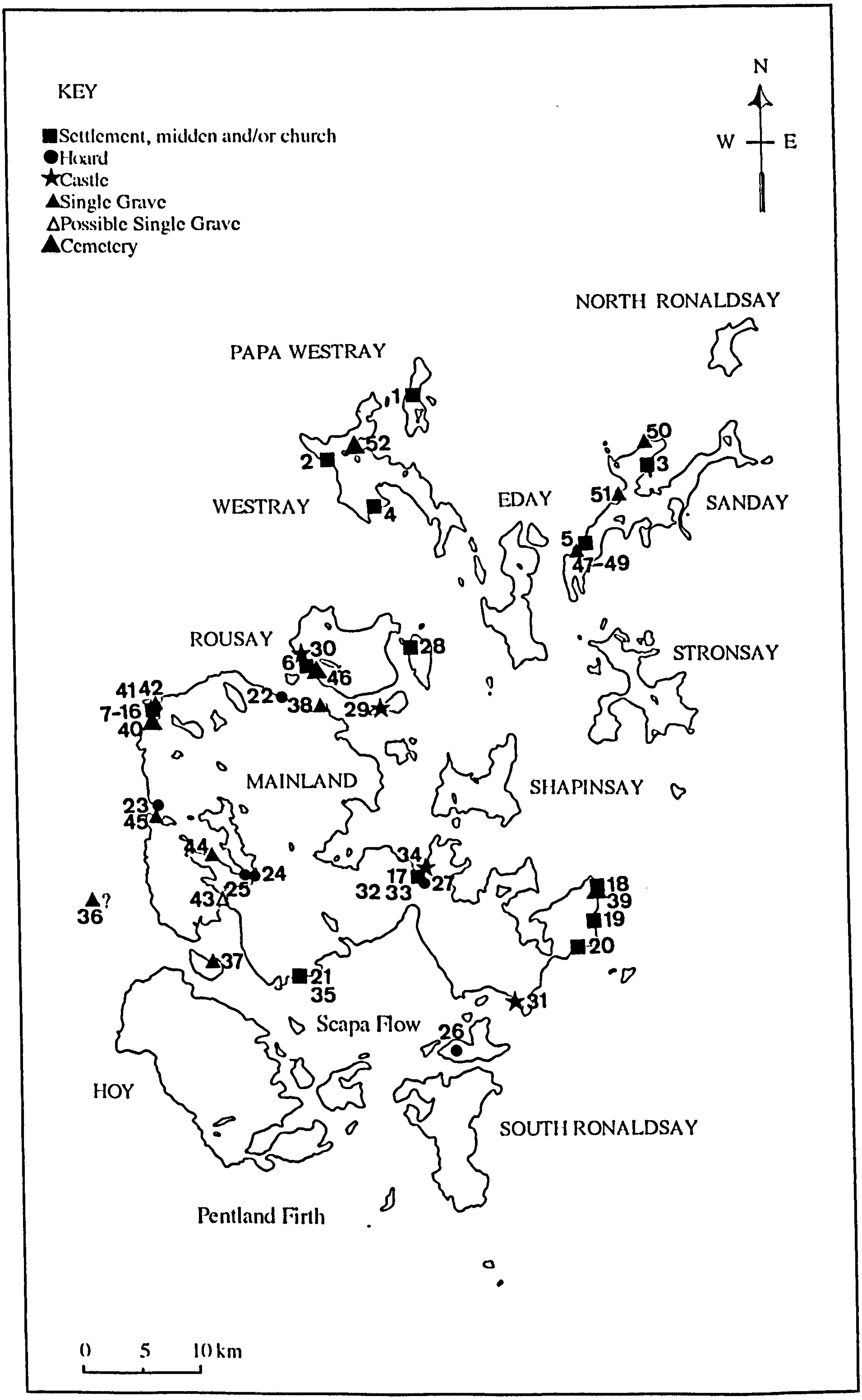


Figure 1.2a. Sites mentioned in the text: Orkney (see over for key to site numbers).

Key to Figure 1.2a (see Appendices 3.1-3.3 for references)

Excavated settlements, middens &/or churches
1 St. Boniface
2 Quoygrew
3 Langskaill
4 Tuquoy
5 Pool
6 Westness Settlement
7 Brough of Birsay Early Excavations
8 Brough of Birsay Room 5
9 Brough of Birsay Sites VII-IX
10 Brough of Birsay Areas 1-6
11 Buckquoy Settlement
12 Brough Road Areas 1 & 2
13 St. Magnus Church, Birsay
14 Beachview Burnside Area 2
15 Beachview Studio Site
16 Saevar Howe
17 Tankerness House, Kirkwall
18 Brough of Deerness
19 Skaill, Deerness
20 Newark Bay
21 Earl's Bu

Hoards
22 Broch of Burgar
23 Skaill
24 Stenness
25 Ring of Brodgar
26 Burray
27 Caldale

Unexcavated (or 'cleared') buildings
28 St. Magnus Church, Egilsay
29 Cubbie Roo's Castle
30 The Wirk
31 Castle Howe
32 St. Olaf's Church, Kirkwall
33 St. Magnus Cathedral, Kirkwall
34 Bishop's Palace, Kirkwall
35 St. Nicholas Chapel, Orphir

Graves and cemeteries
36 Location Unknown (an Island near Mainland)
37 Graemsay
38 Broch of Gurness
39 Brough of Deerness
40 Brough Road Areas 1 & 2
41 Buckquoy Adult Burial
42 Buckquoy Infant Burial
43 Howe
44 Lyking
45 Skaill
46 Westness (Including the Knowe of Swandro)
47 Braeswick
48 Lamba Ness (NMS IL179-181)
49 Lamba Ness (NMS IL347-350)
50 Scar
51 Sties
52 Pierowall

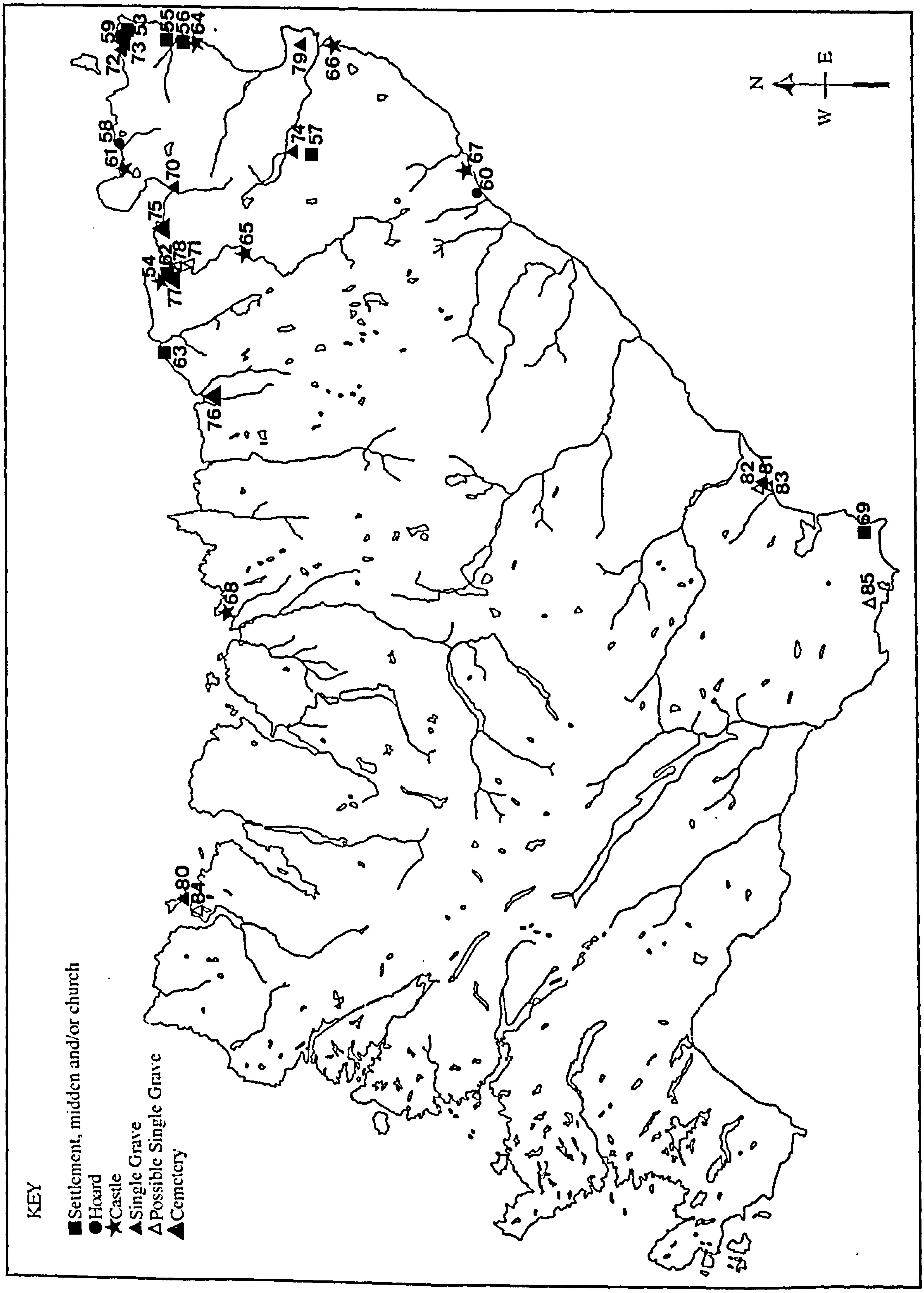


Figure 1.2b. Sites mentioned in the text: Caithness (see over for key to site numbers).

Key to Figure 1.2b (see Appendicies 3.1-3.3 for references)

Excavated settlements, middens &/or churches
- 53 Robert's Haven
- 54 Bishop's Castle
- 55 Freswick Links
- 56 Freswick Castle
- 57 Clow Chapel

Hoards
- 58 Kirk o' Banks
- 59 Ladykirk
- 60 Braemore

Unexcavated (or 'cleared') buildings
- 61 Castle of Brough
- 62 St. Peter's Church, Thurso
- 63 St. Mary's Chapel, Crosskirk
- 64 Bucholie Castle
- 65 Braal Castle
- 66 Castle of Old Wick
- 67 Forse Castle
- 68 Borve Castle
- 69 Dornoch Cathedral

Graves and cemeteries
- 70 Castletown
- 71 Haimar
- 72 Huna
- 73 John O'Groats
- 74 Mill of Watten
- 75 Murkle Bay
- 76 Reay
- 77 St Peter's Church-yard
- 78 Thurso East
- 79 Westerseat
- 80 Balnakeil
- 81 Dunrobin
- 82 Dunrobin IL 209
- 83 Dunrobin Shore
- 84 Keodale
- 85 Ospisdale

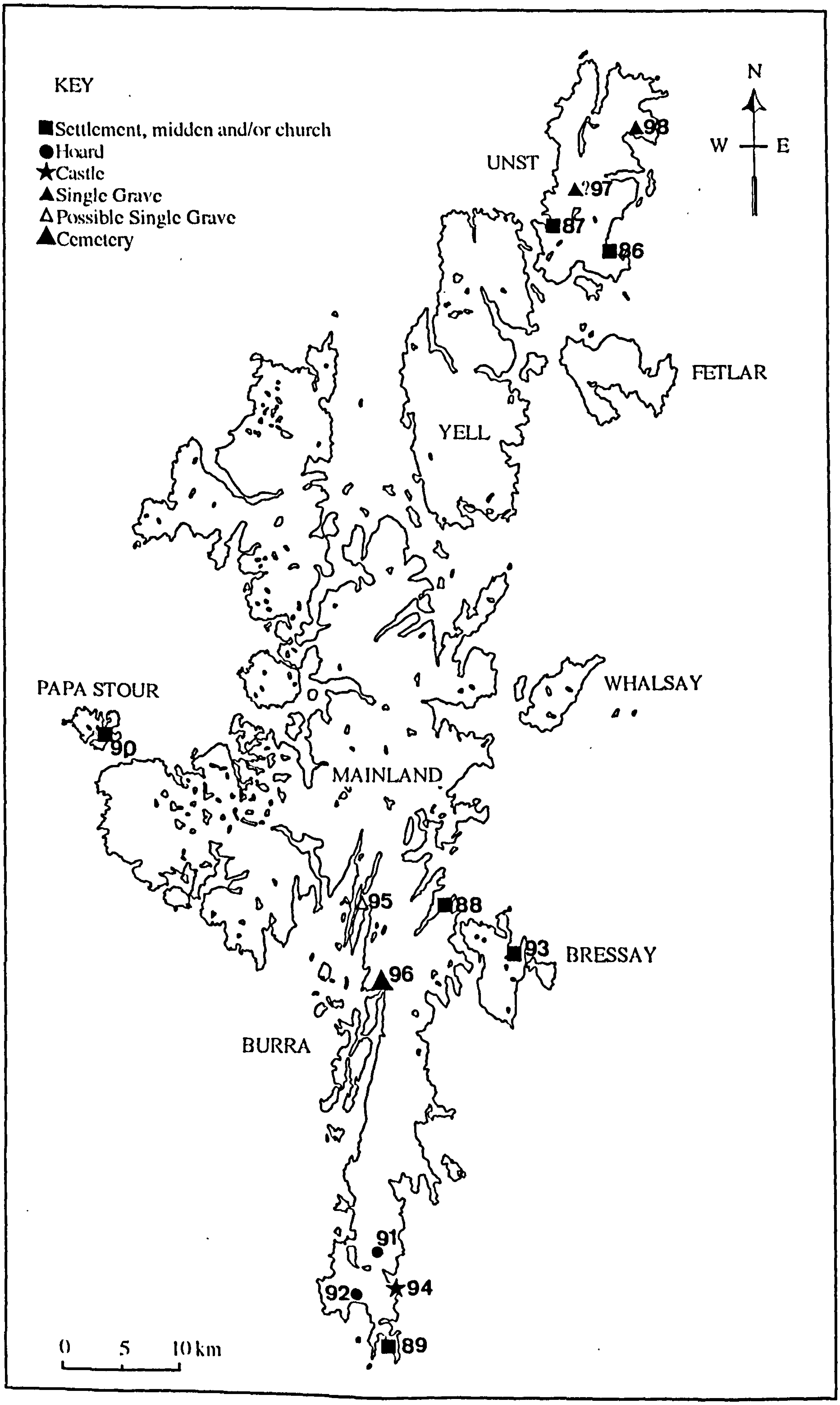


Figure 1.2c. Sites mentioned in the text: Shetland (see over for key to site numbers).

Key to Figure 1.2c (see Appendicies 3.1-3.3 for references)

Excavated settlements, middens &/or churches
86 Sandwick
87 Underhoull
88 Kebister
89 Jarlshof
90 The Biggins

Hoards
91 Dunrossness Manse
92 Garthbanks/Quendale

Unexcavated (or 'cleared') buildings
93 St. Mary's Church, Bressay
94 Lambhoga Head (Castle?)

Graves and cemeteries
95 St. Olaf's Churchyard
96 Upper Scalloway
97 NMS IL313-14, Unst
98 Clibberswick

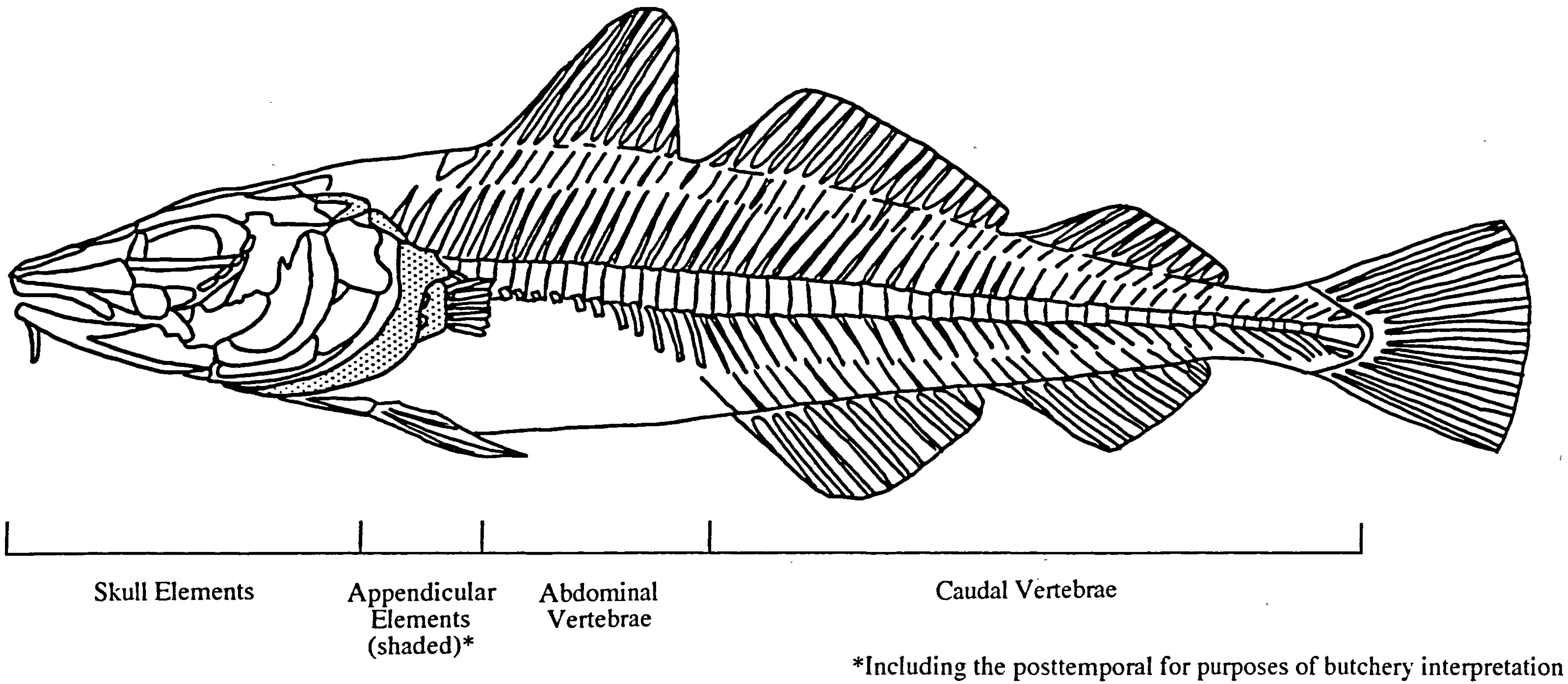
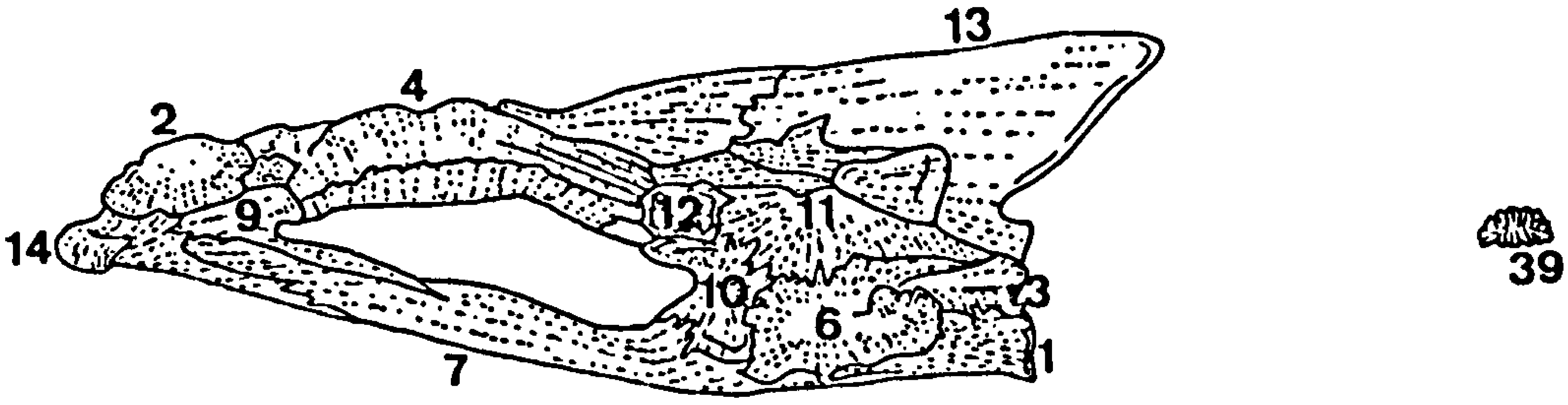
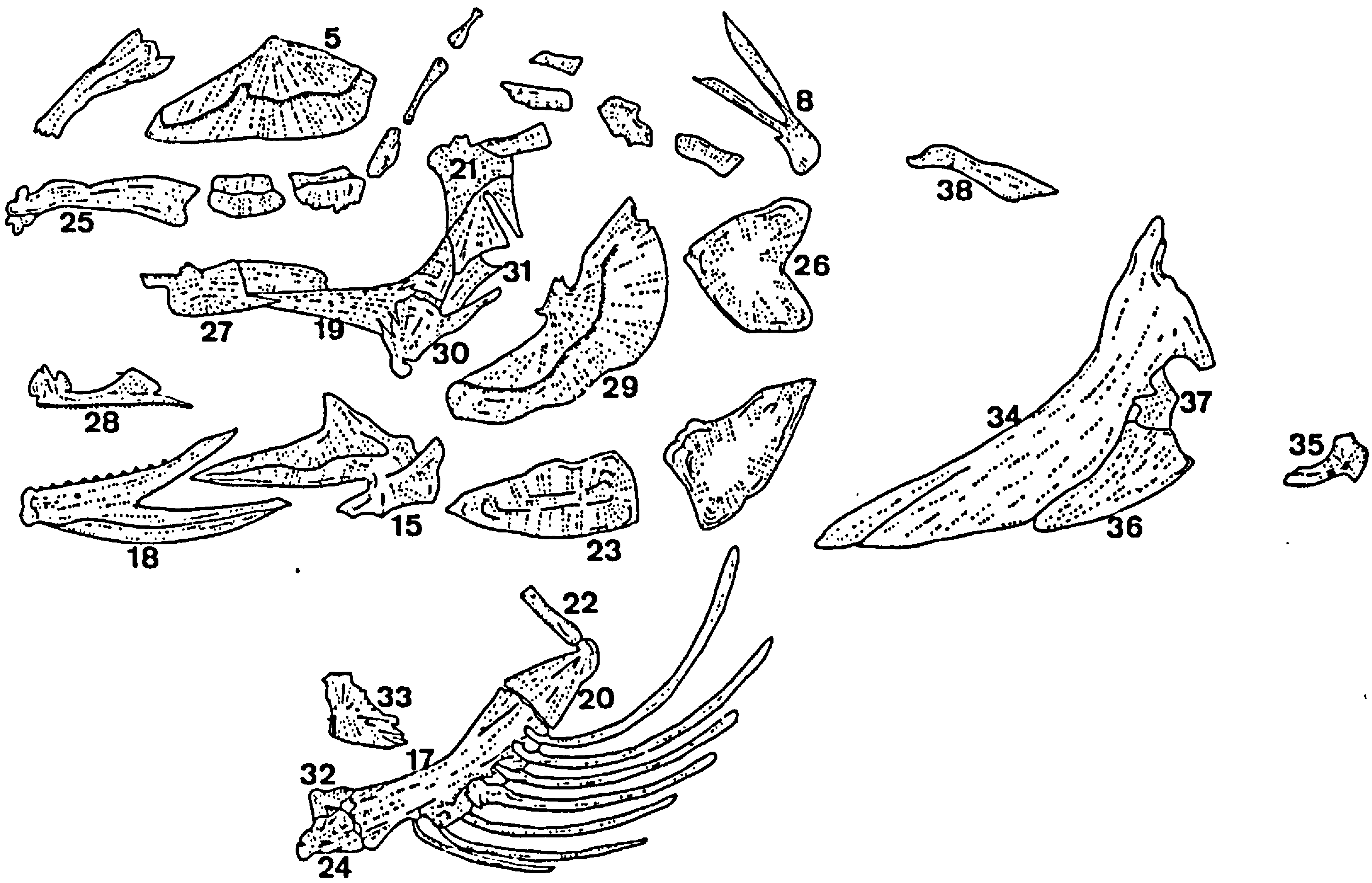


Figure 1.3a. The Gadoid Skeleton: Principal anatomical regions (after Brinkhuizen 1994:199).



Neurocranium:

1 Basioccipital	5 Lacrimal	9 Prefrontal	13 Supraoccipital
2 Ethmoid	6 Opisthotic	10 Prootic	14 Vomer
3 Exoccipital	7 Parasphenoid	11 Pterotic	Other:
4 Frontal	8 Posttemporal*	12 Sphenotic	39 Otolith



Branchiocranium:			Appendicular Skeleton:
15 Articular	22 Interhyal	29 Preopercular	34 Cleithrum
16 Basibranchial	23 Interopercular	30 Quadrate	35 Basipterygium
17 Ceratohyal	24 Lower Hypohyal	31 Symplectic	36 Coracoid
18 Dentary	25 Maxilla	32 Upper Hypohyal	37 Scapula
19 Ectopterygoid	26 Opercular	33 Urohyal	38 Supracleithrum
20 Epihyal	27 Palatine		
21 Hyomandibular	28 Premaxilla		

*The posttemporal is associated with the appendicular skeleton in this thesis for purposes of butchery study.

Figure 1.3b. The Gadoid Skeleton: Principal elements of the skull and appendicular region (after Wheeler & Jones 1989:92, 99, 100, 103).

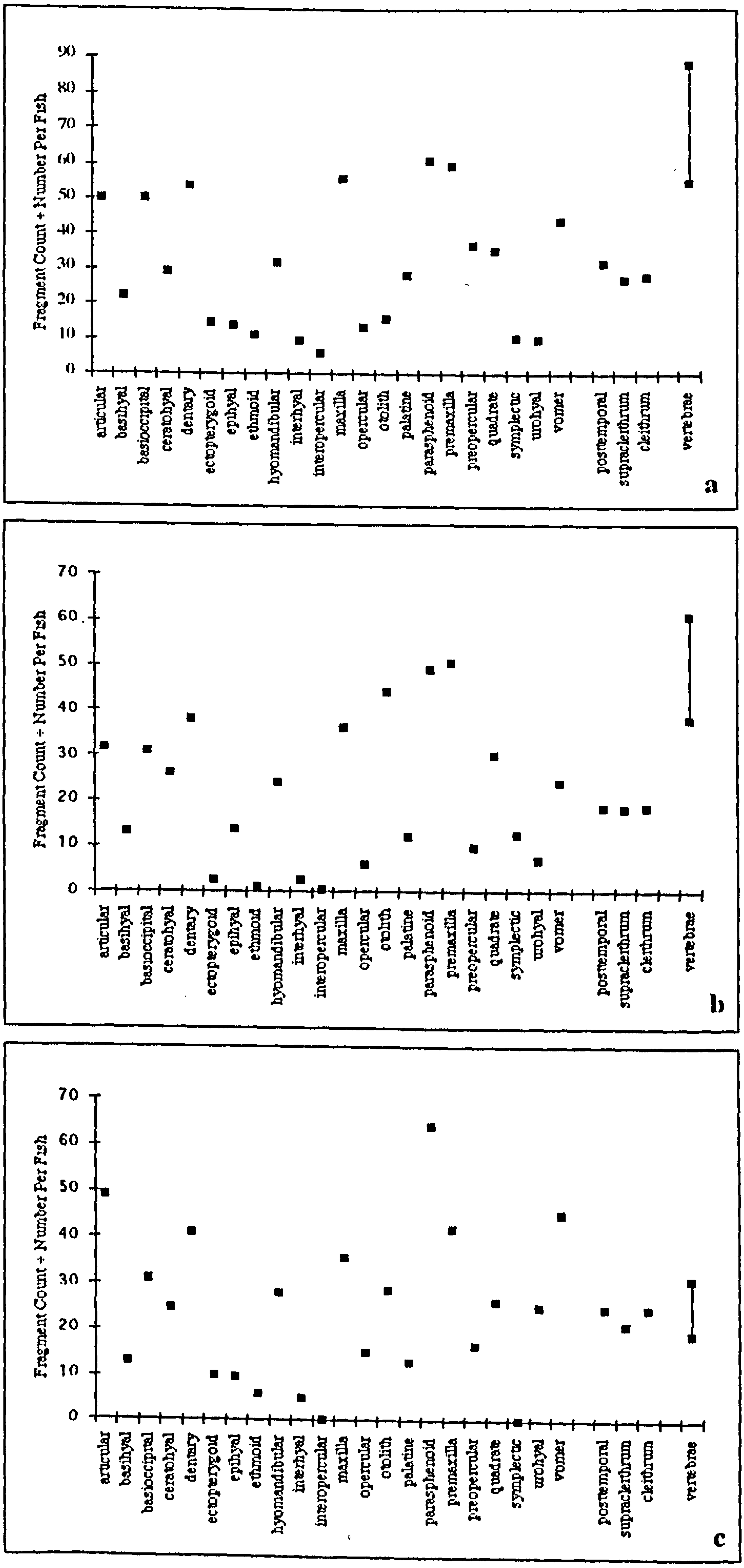
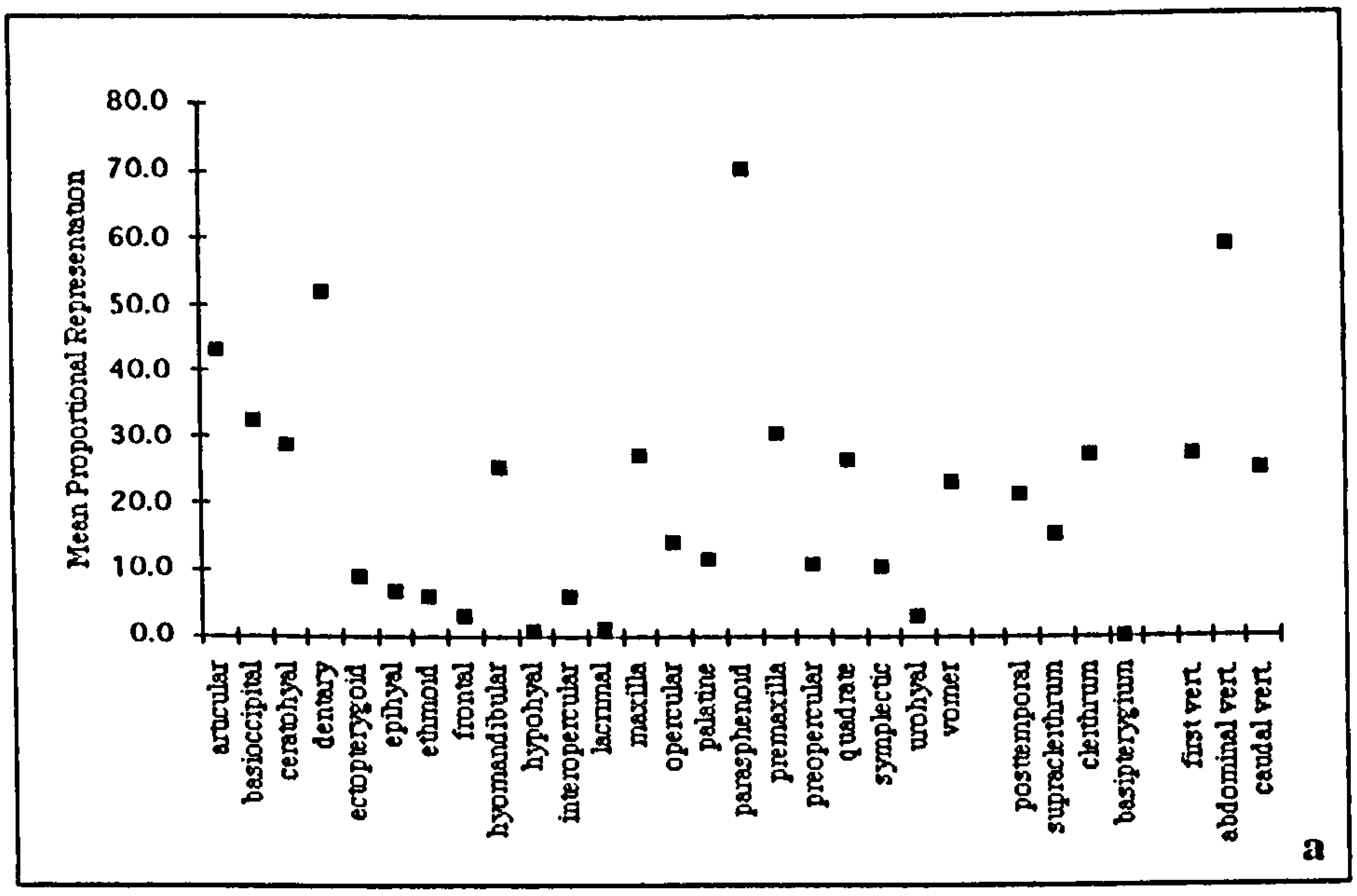


Figure 1.4. Relative representation of gadoid skeletal elements from three Orcadian fish bone assemblages analysed by Sarah Colley: Quoygrew (a), Tuquoy (b) and Brough Road Areas 1 and 2 (c) (see Table 1.2 for references).



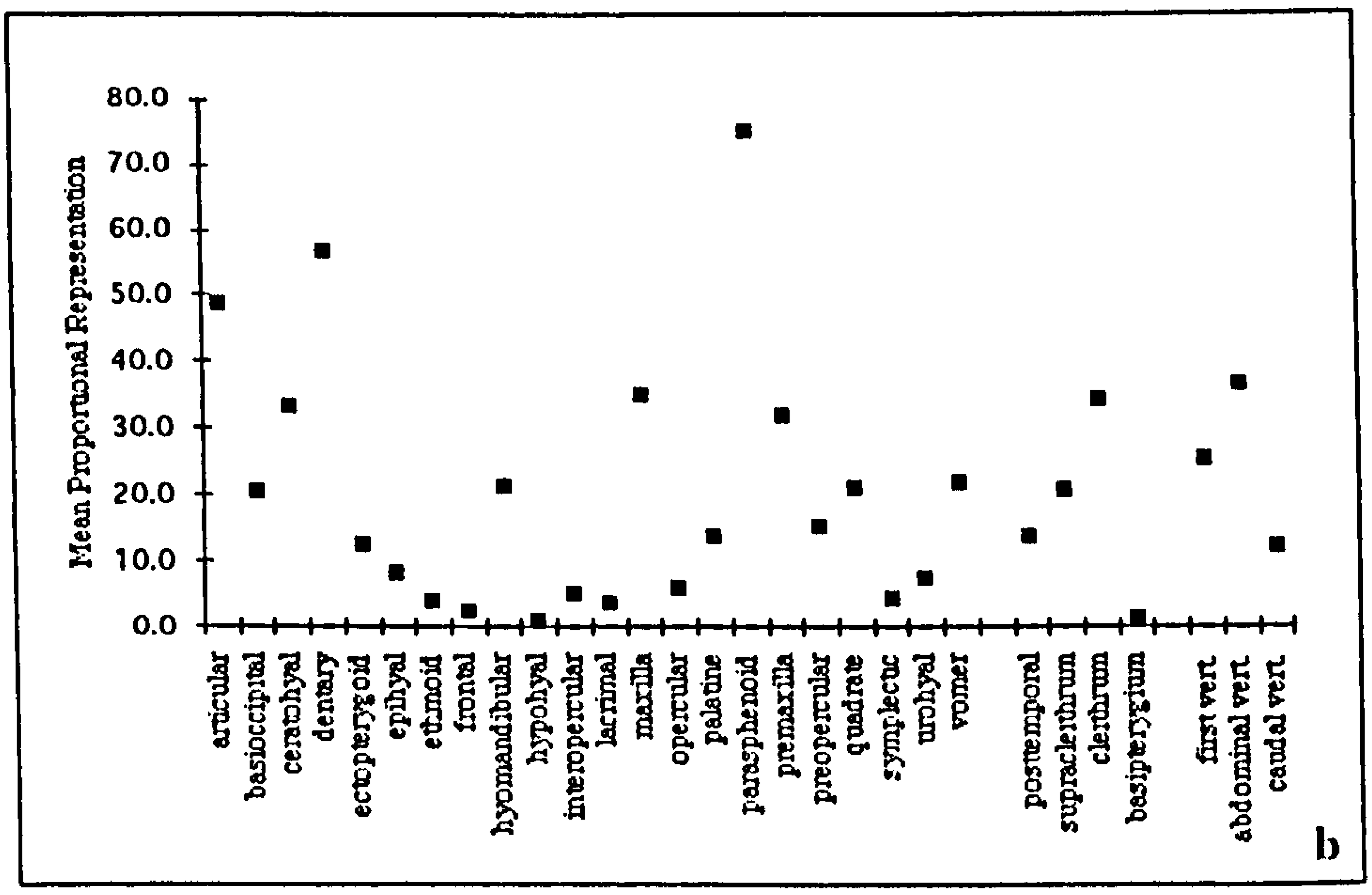


Figure 1.5. Relative representation of gadoid skeletal elements from Pool, Orkney, Phases 7 (a) and 8 (b) (see Table 1.5 for references).

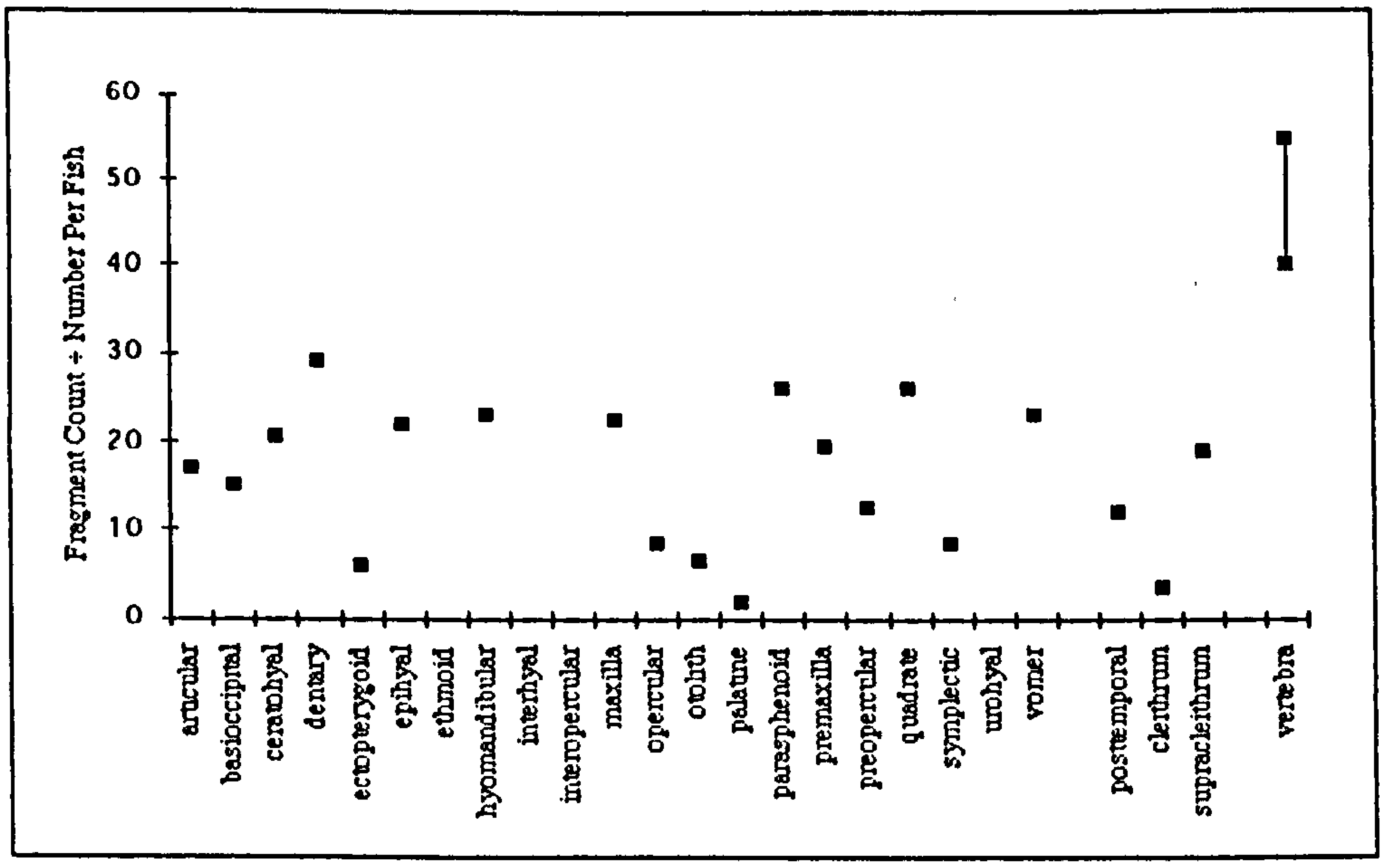


Figure 1.6. Relative representation of gadoid skeletal elements from St. Boniface, Orkney (see Table 1.2 for references).

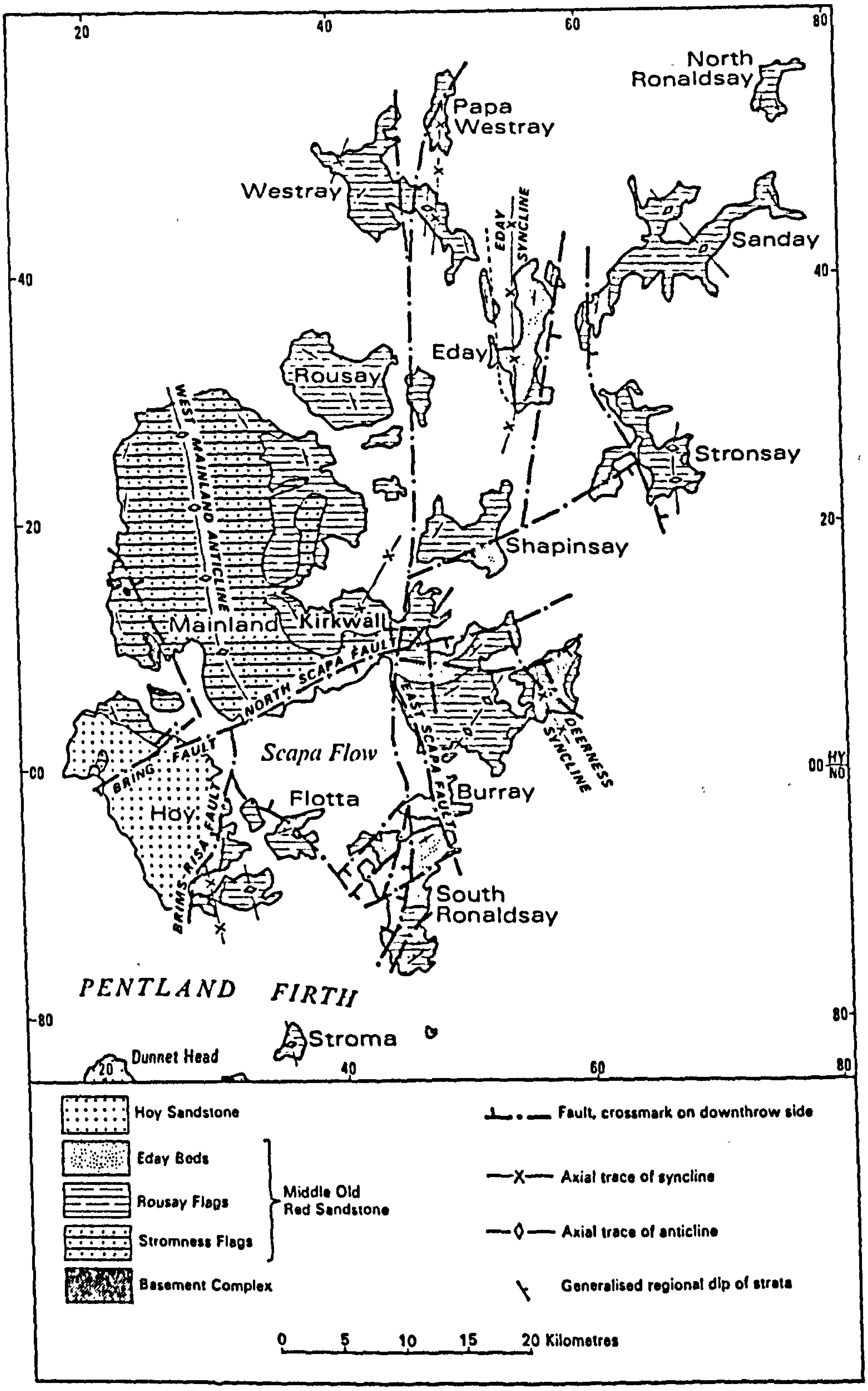


Figure 2.1a. Solid geology of Orkney (from Mykura 1976:10).

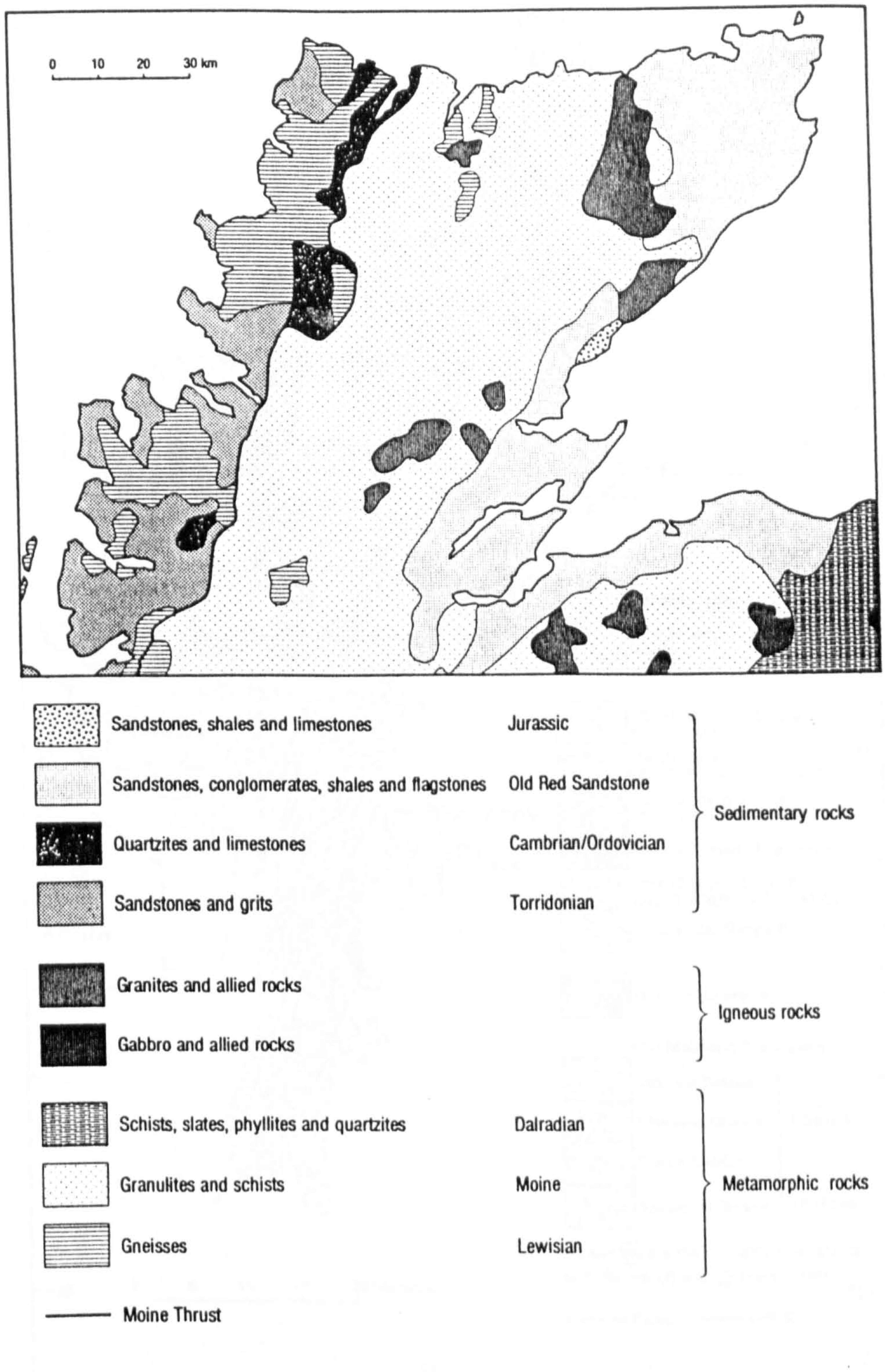


Figure 2.1b. Solid geology of northern Scotland (from Futty & Towers 1982:2-3).

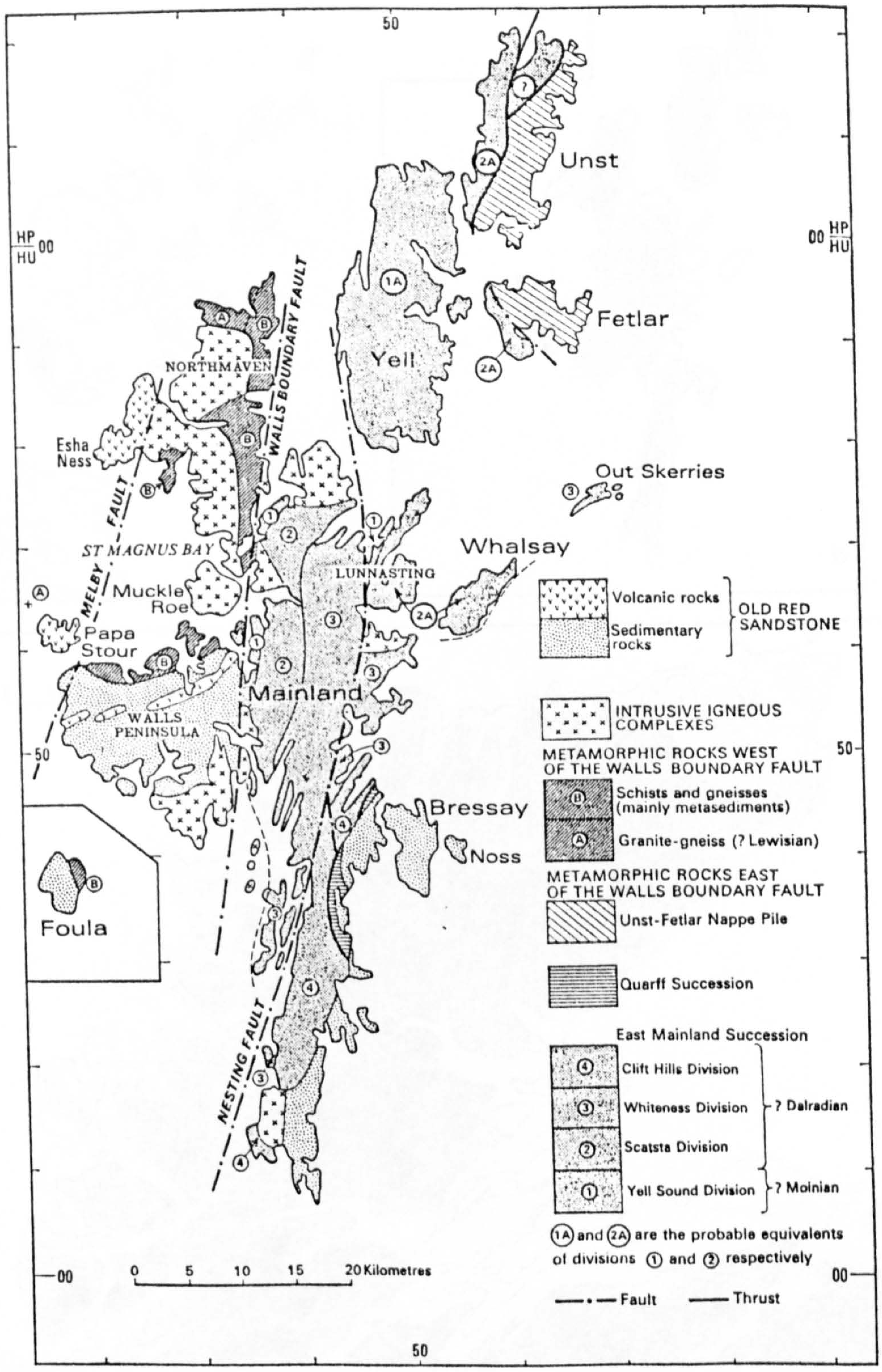


Figure 2.1c. Solid geology of Shetland (from Mykura 1976:6).

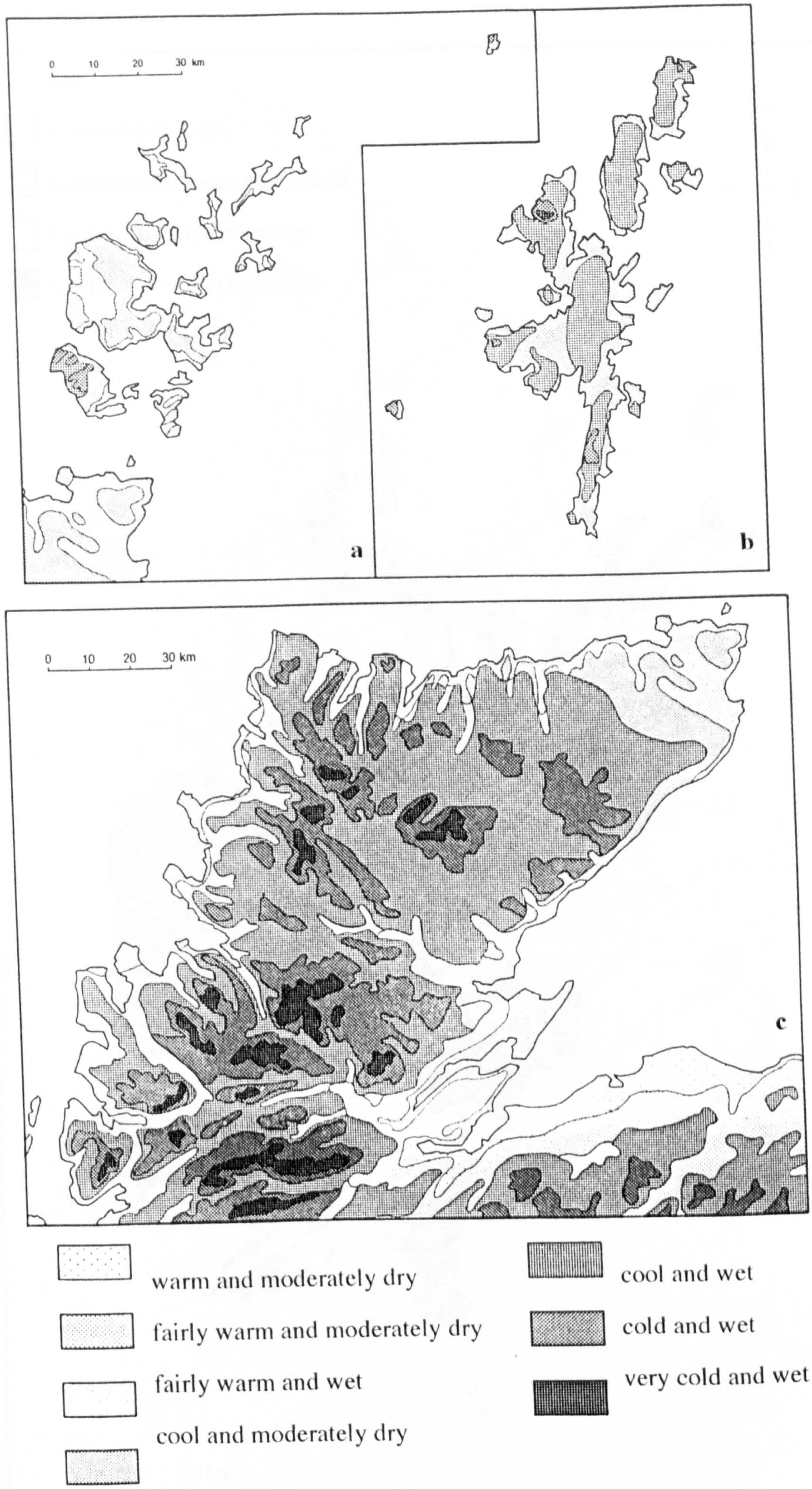


Figure 2.2. Climate regions of Orkney (a), Shetland (b) and the northern mainland of Scotland (c) (from Dry & Robertson 1982:10; Futty & Towers 1982:10).

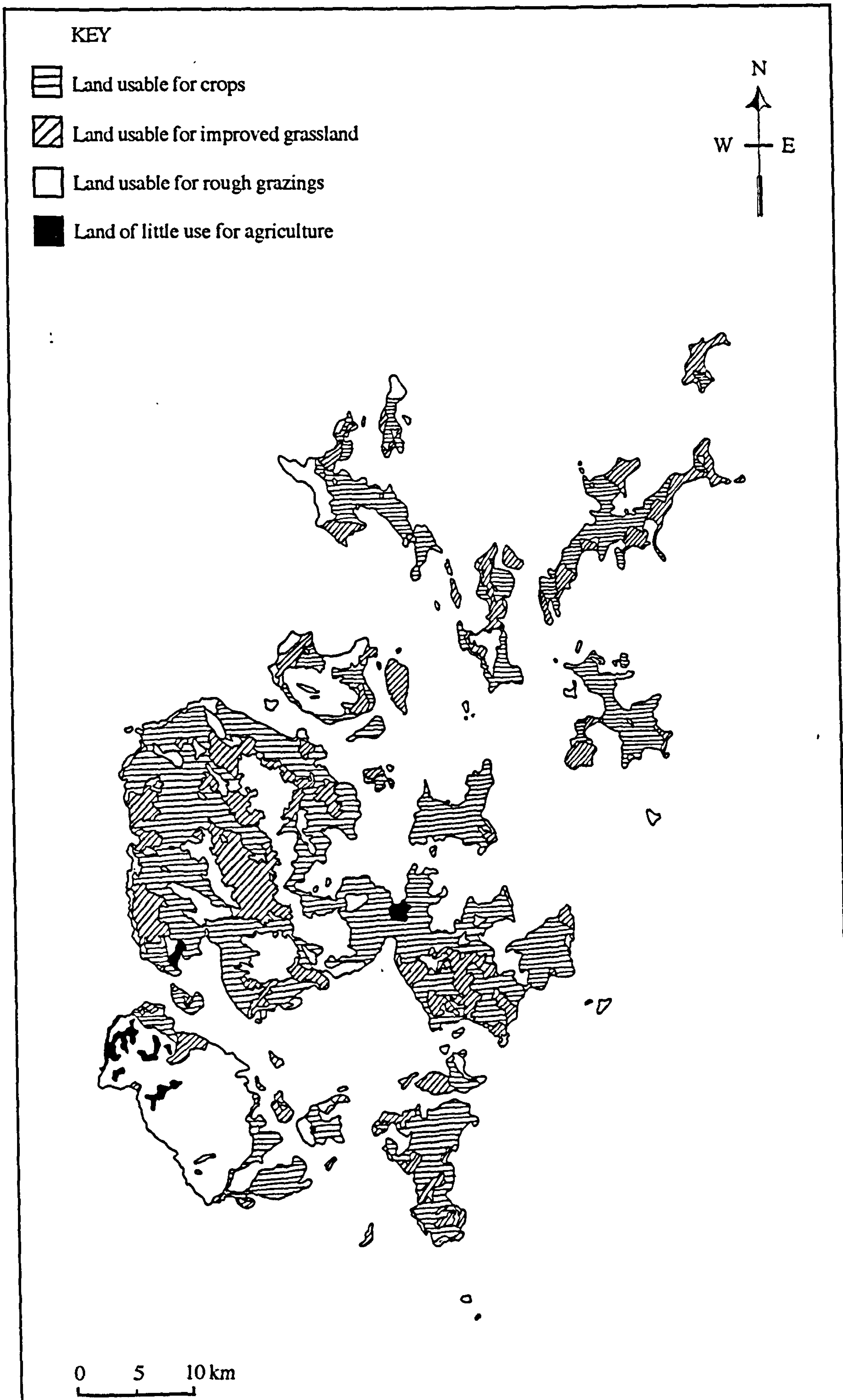


Figure 2.3a. Modern land use potential for agriculture of Orkney (after Macaulay Institute for Soil Research 1983b).

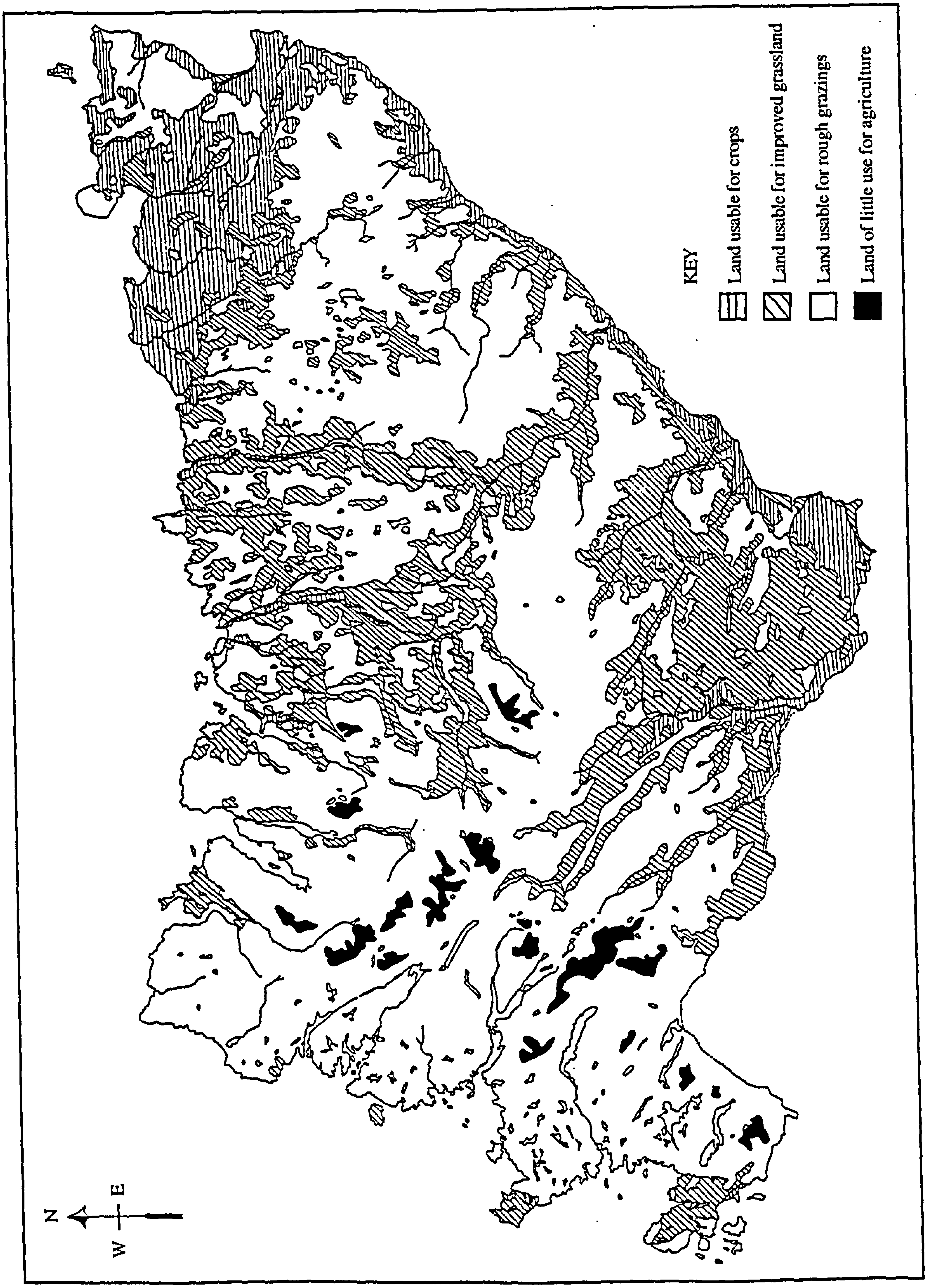


Figure 2.3b. Modern land use potential for agriculture of northern Scotland (after Macaulay Institute for Soil Research 1983a).

Figure 2.3c. Modern land use potential for agriculture of Shetland (after Macaulay Institute for Soil Research 1983b).

Figure 2.4. Farmed land in Scotland based on The Military Survey of Scotland 1747-1755 (from O'Dell 1953:60).

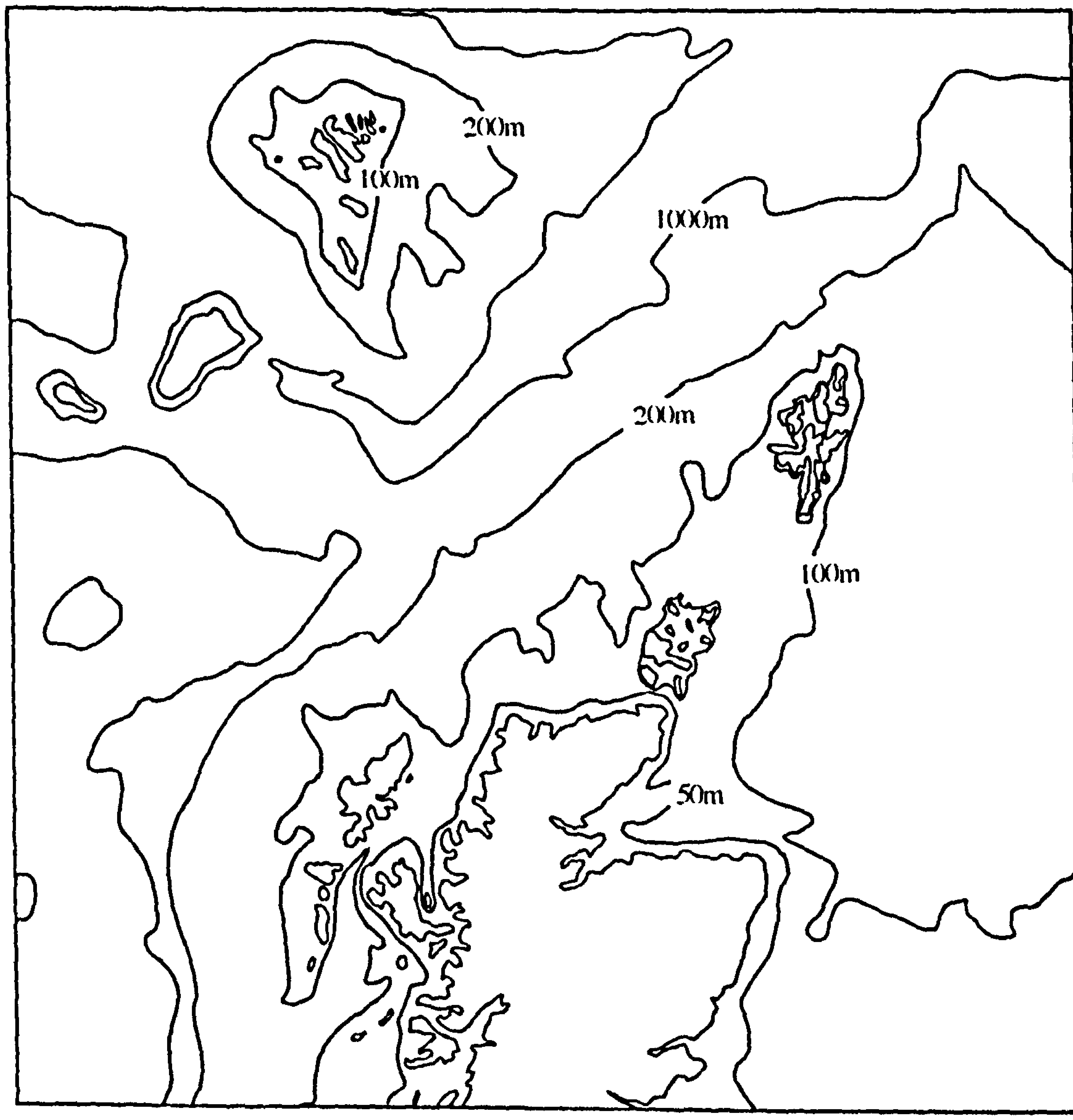


Figure 2.5. Sea floor topography of the study area (after Hydrographic Office 1993c; Lee & Ramster 1981:2.00).

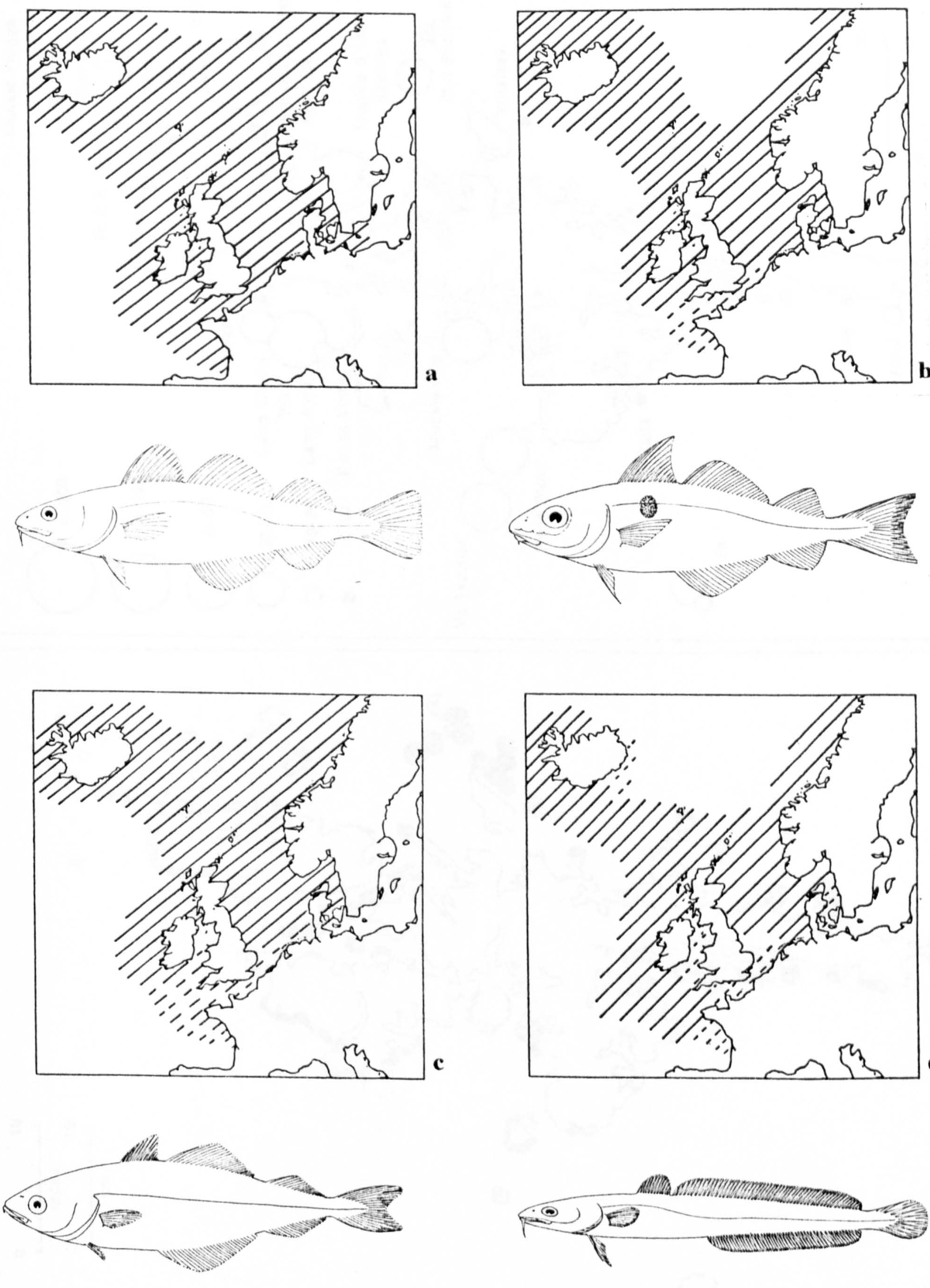


Figure 2.6. Distribution of cod (a), haddock (b), saith (c) and ling (d) in British waters (from Wheeler 1969:274-278, 284-285).

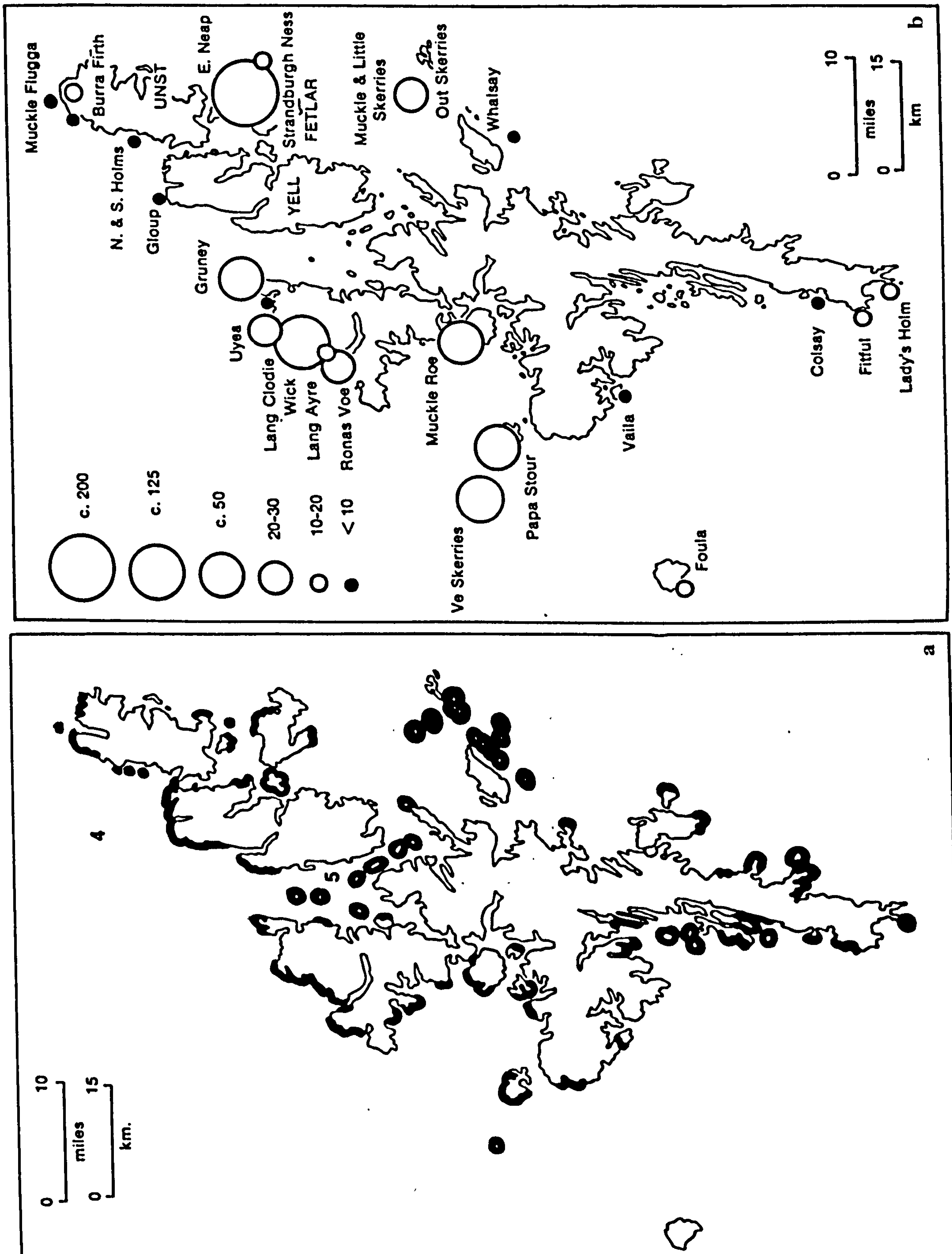


Figure 2.7. Basking and pupping locations for common seal (a) and grey seal (b) in Shetland. The counts in (b) are the numbers of grey seal pups born annually (from Berry & Johnston 1980:111, 115). Similar seal populations occur in Orkney and coastal Caithness (e.g. Berry 1985:108).

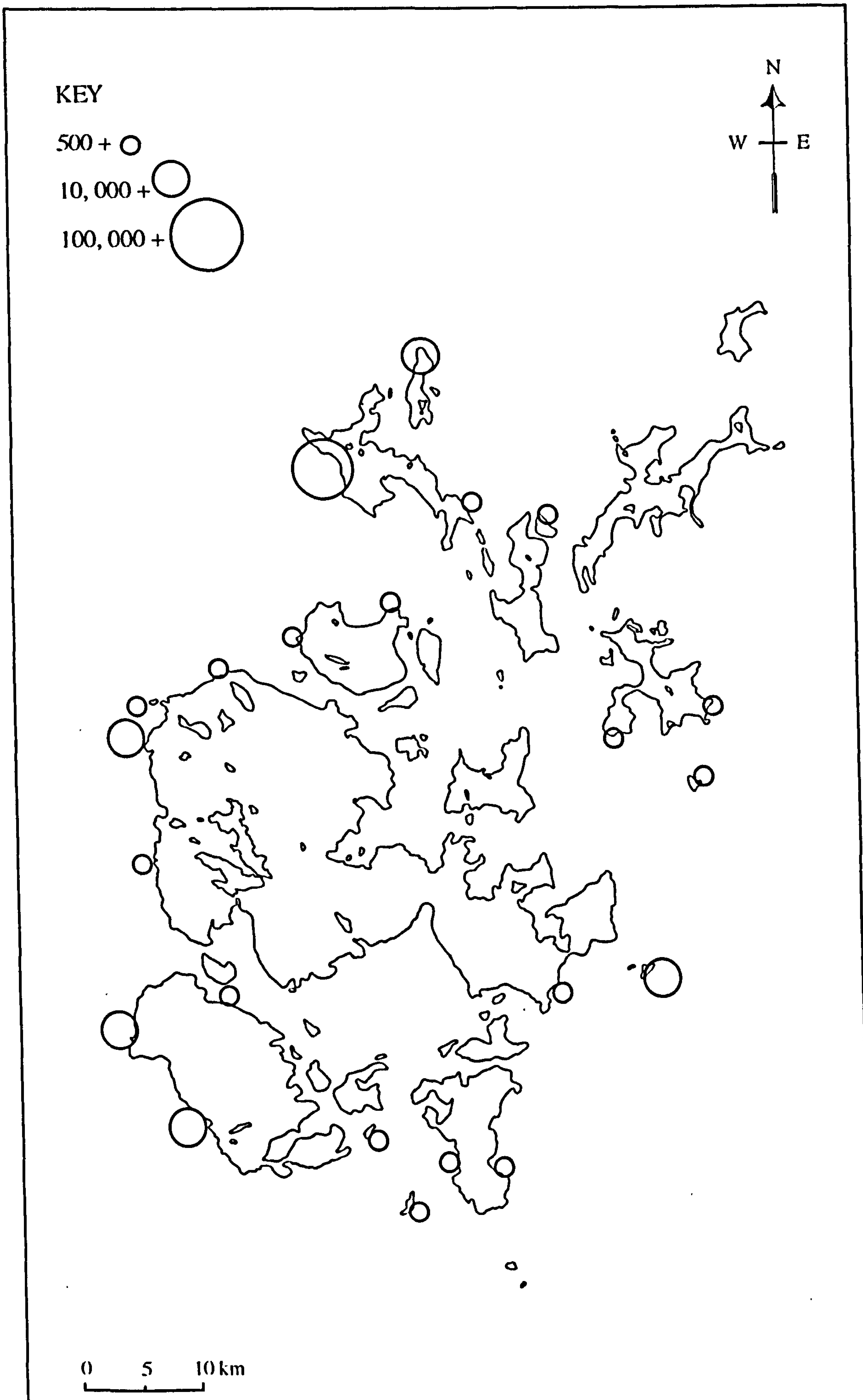


Figure 2.8a. Main seabird colonies in Orkney (after Berry 1985:141).

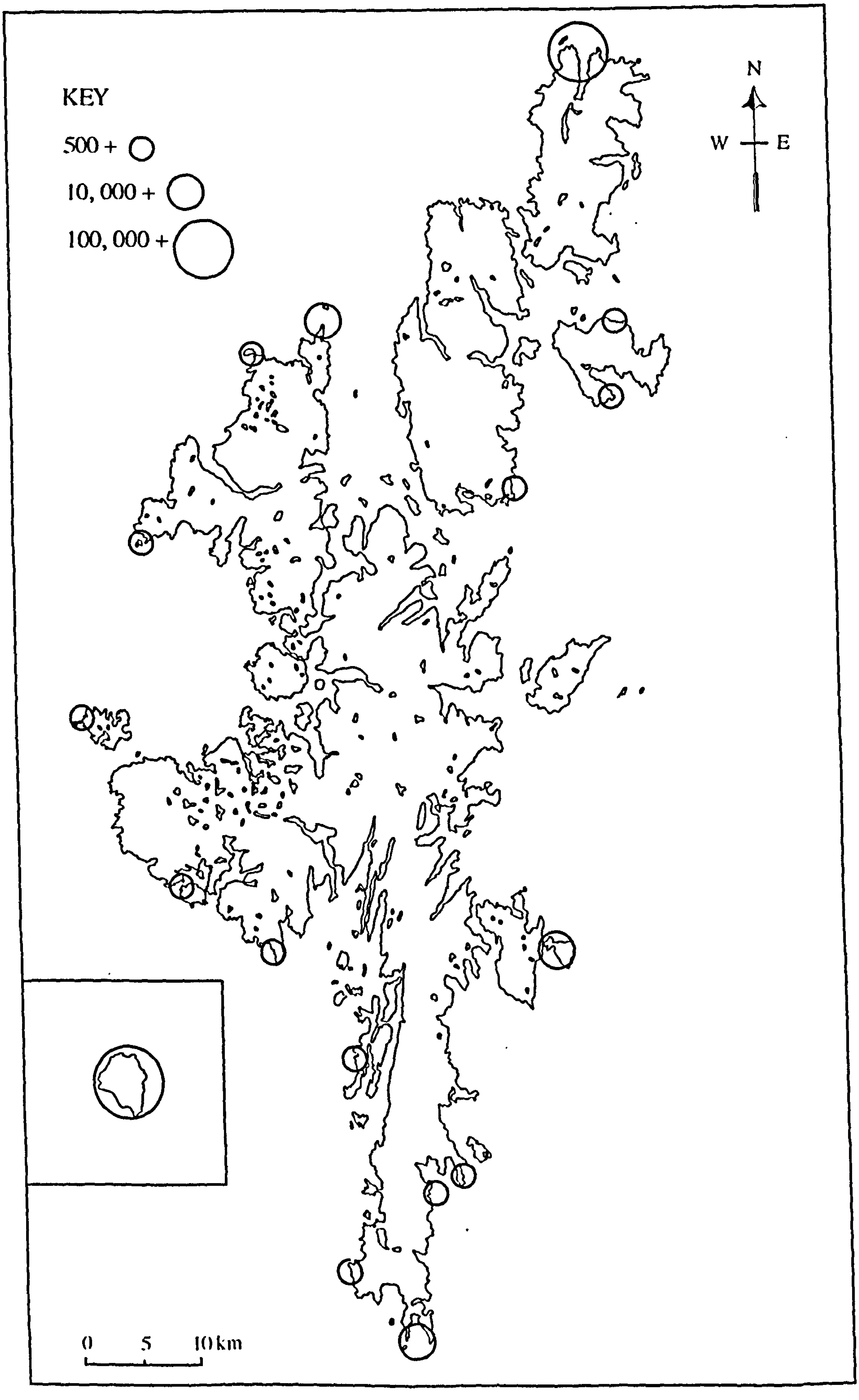


Figure 2.8b. Main seabird colonies in Shetland (after Berry & Johnston 1985: 189).

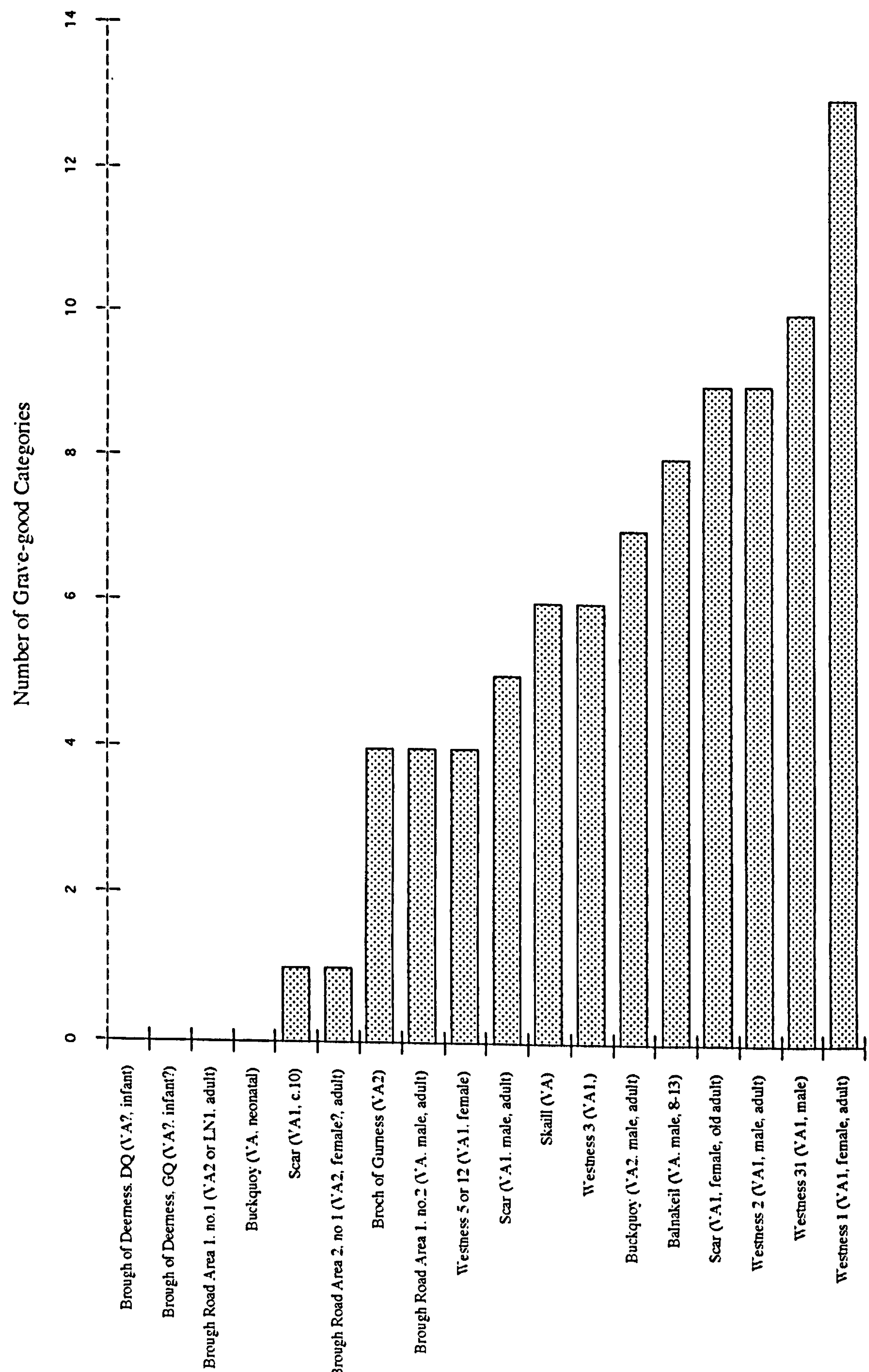


Figure 4.1. Number of grave-good categories in Viking Age burials from Orkney, Caithness and Shetland - complete and nearly complete records only. Where known, the approximate period of burial and the sex and age of the interred are noted (see Appendix 3.3 for references).

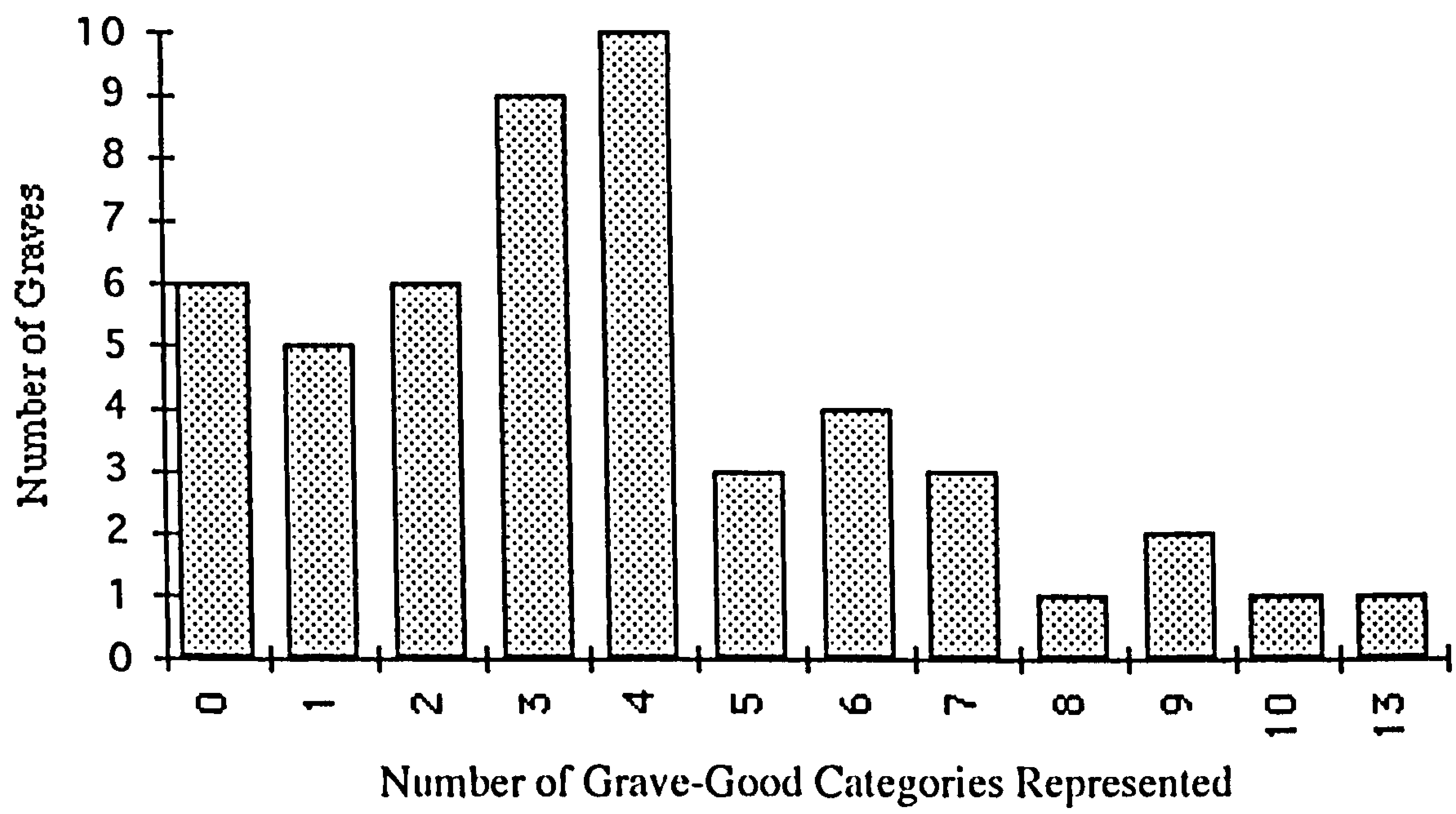


Figure 4.2. Frequency distribution of the number of grave-good categories in Viking Age burials from Orkney, Caithness and Shetland - excluding stray finds possibly from graves (see Appendix 3.3 for references).

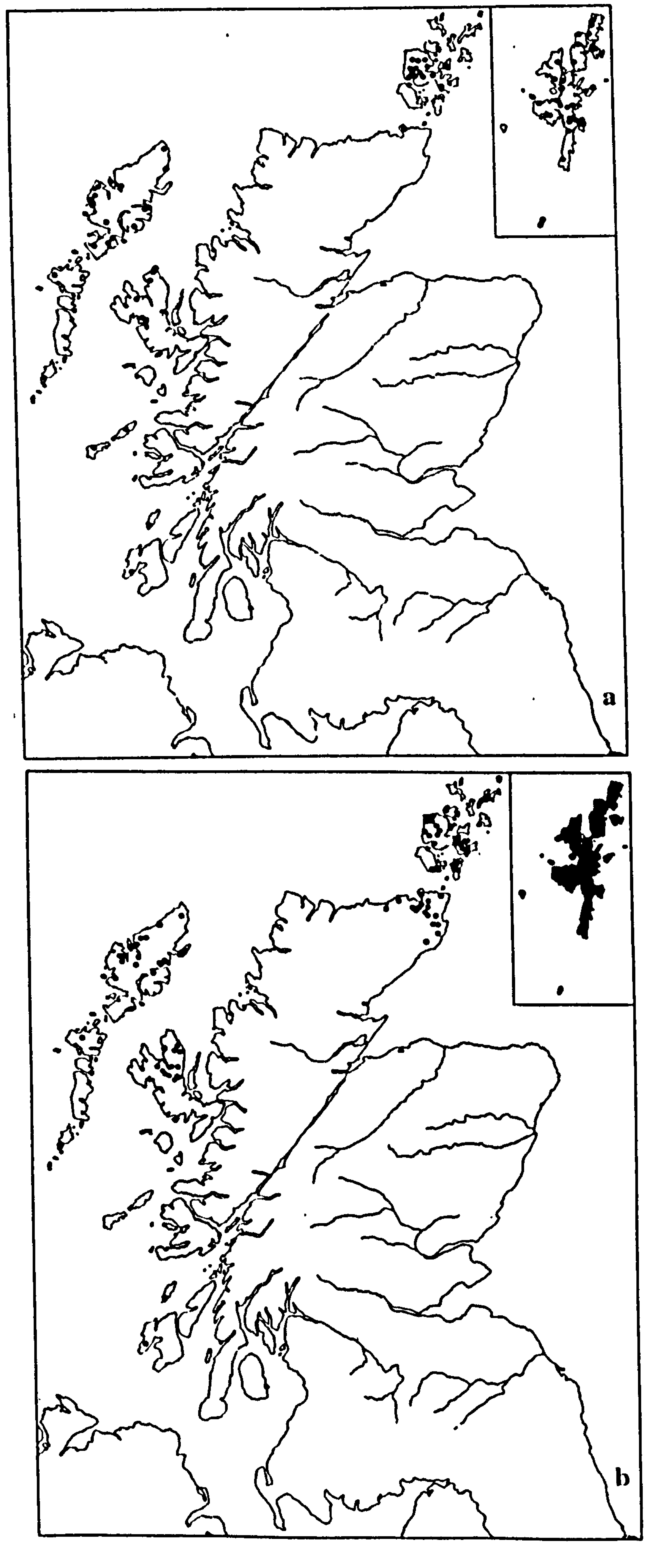


Figure 4.3a-b. Distribution of several Norse place-names in Scotland: *-staðir* (a), *-setr/sætr* (b). Shading indicates areas of frequent occurrence (from Nicolaisen 1976:88-89, 93, 95).

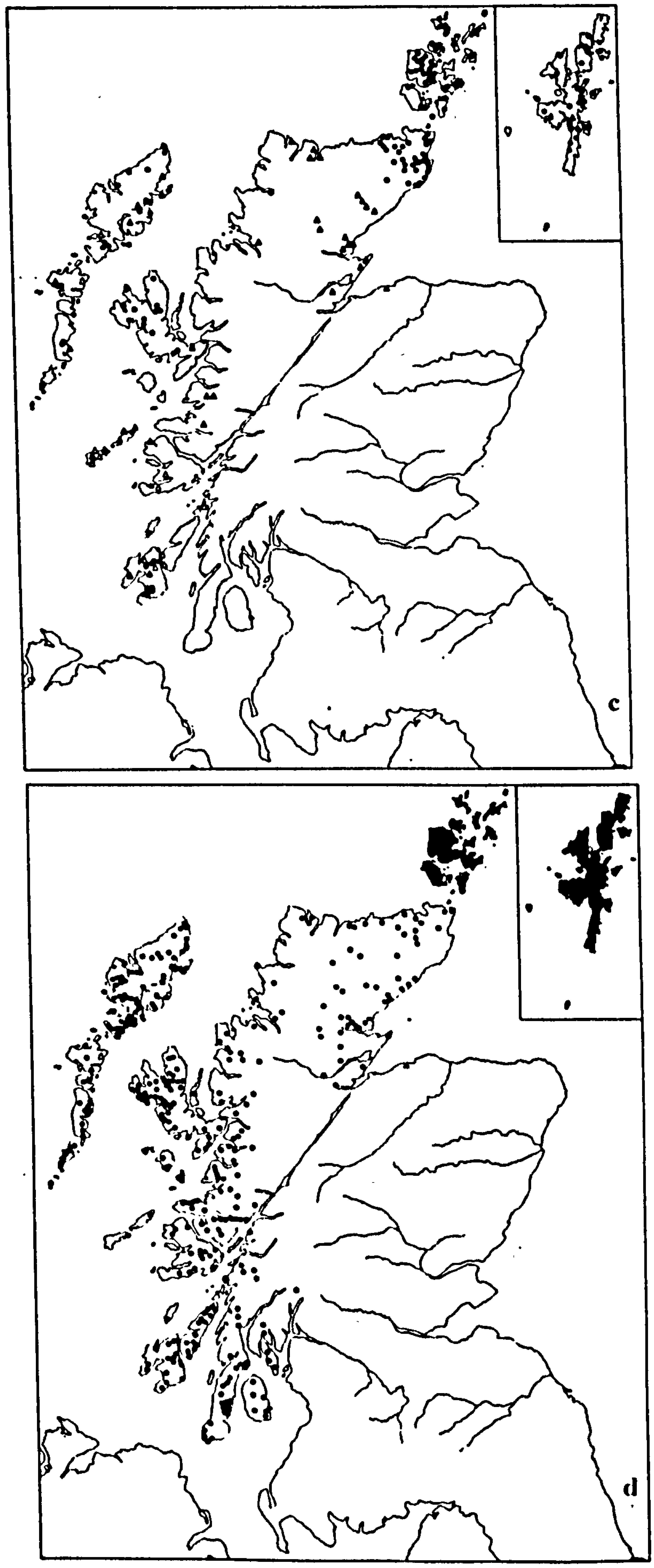


Figure 4.3c-d. Distribution of several Norse place-names in Scotland: *-bolstaðir* (c) and *-dalr* (d). Shading indicates areas of frequent occurrence (from Nicolaisen 1976:88-89, 93, 95).

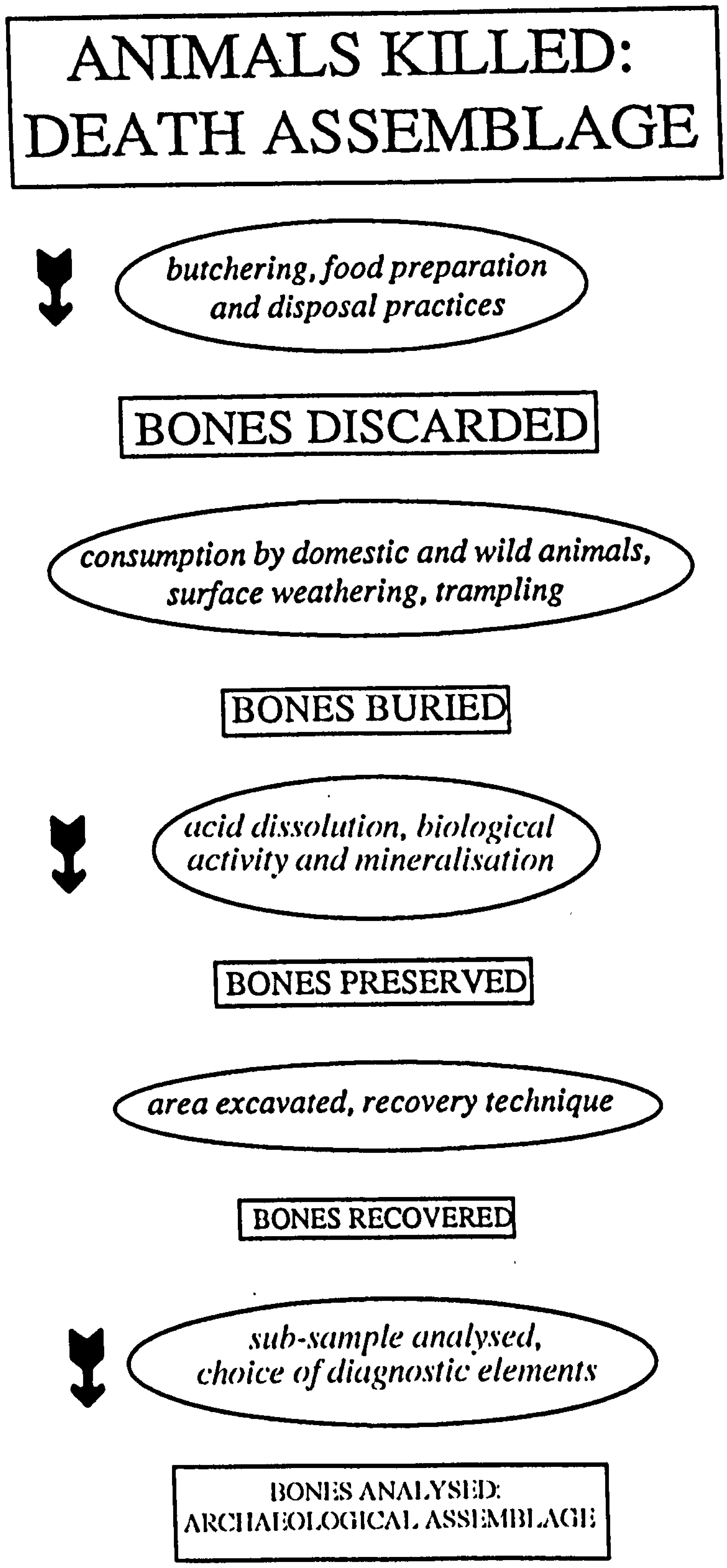


Figure 5.1. A taphonomic model of bone loss (based on Lyman 1994:31).

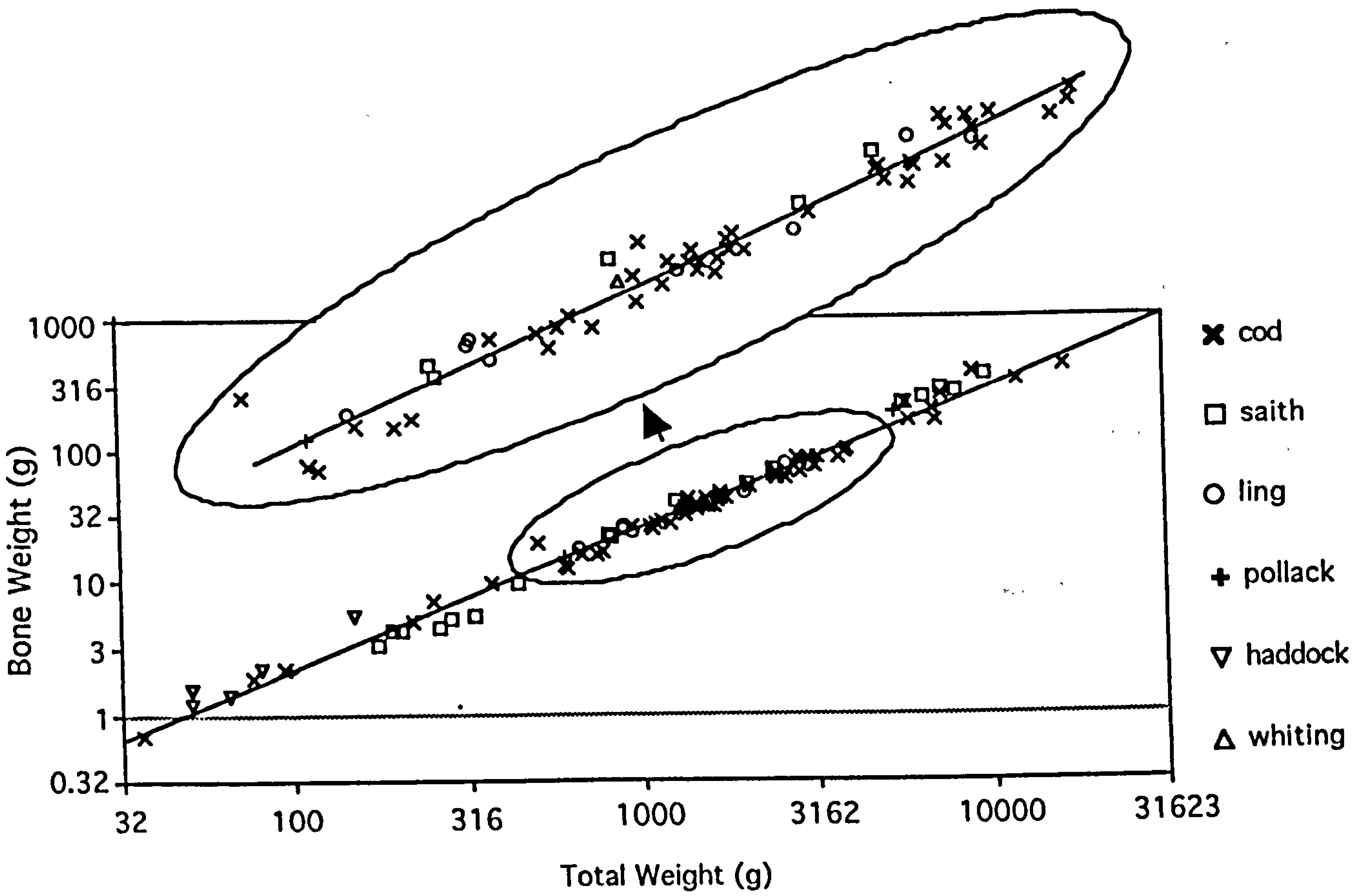


Figure 5.2. Allometric relationship between total fish weight (TW) and total bone weight(BW) in cod family (Gadidae) fishes $BW=0.01642TW^{1.06524}$ (n=91, $r^2=98.7$, p=<0.001).

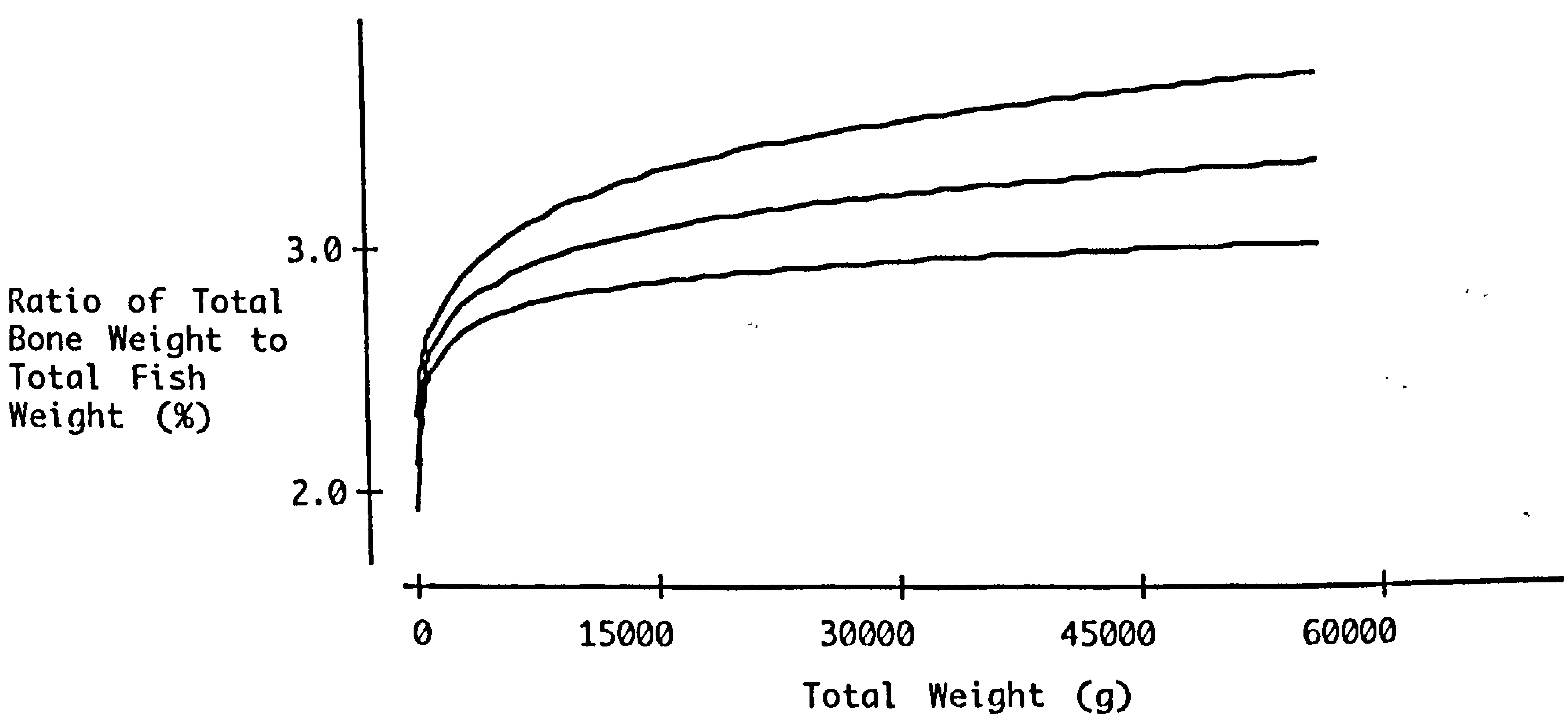


Figure 5.3. Size dependent changes in the ratio of total bone weight/total fish weight (including 95% confidence intervals) for gadoid fishes as a family (data predicted from the allometric regression equation relating bone weight and body weight illustrated in Figure 5.2).

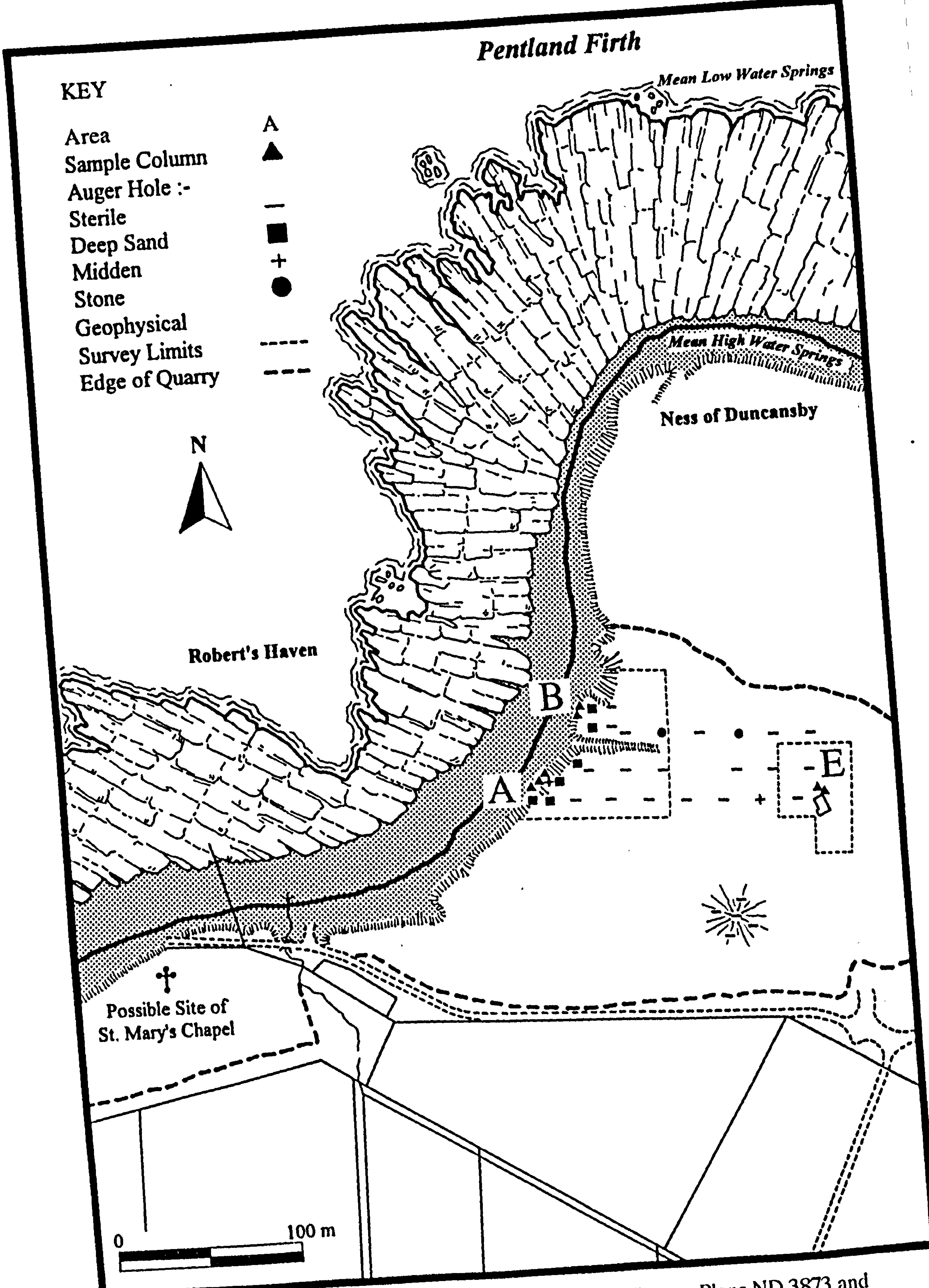


Figure 5.4. Robert's Haven Project Map (after Ordnance Survey Plans ND 3873 and ND 3973, and Scottish Development Department 1975 Coastal Strip aerial photograph by kind permission of the Royal Commission on the Ancient and Historical Monuments of Scotland).

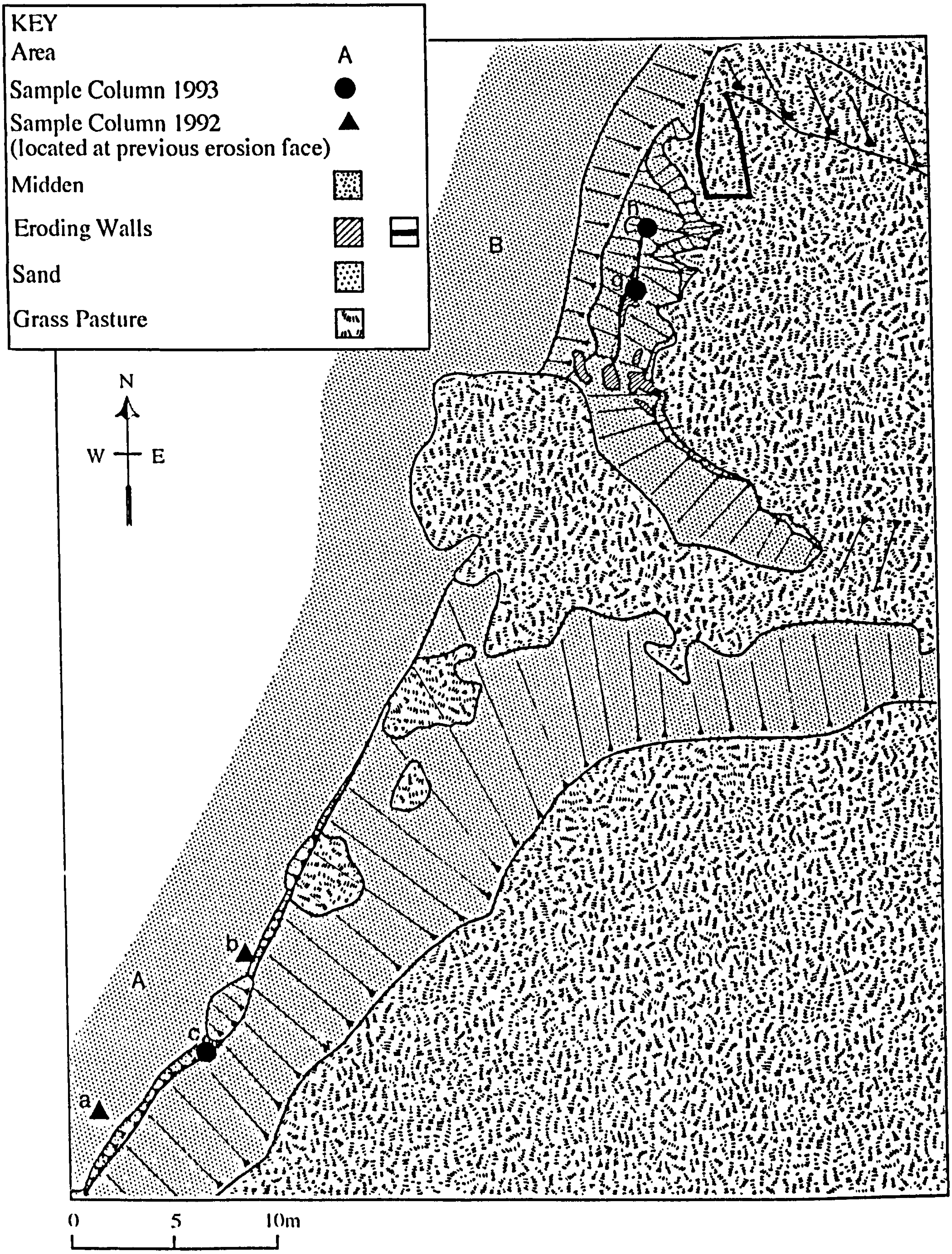


Figure 5.5. Robert's Haven, Areas A and B.

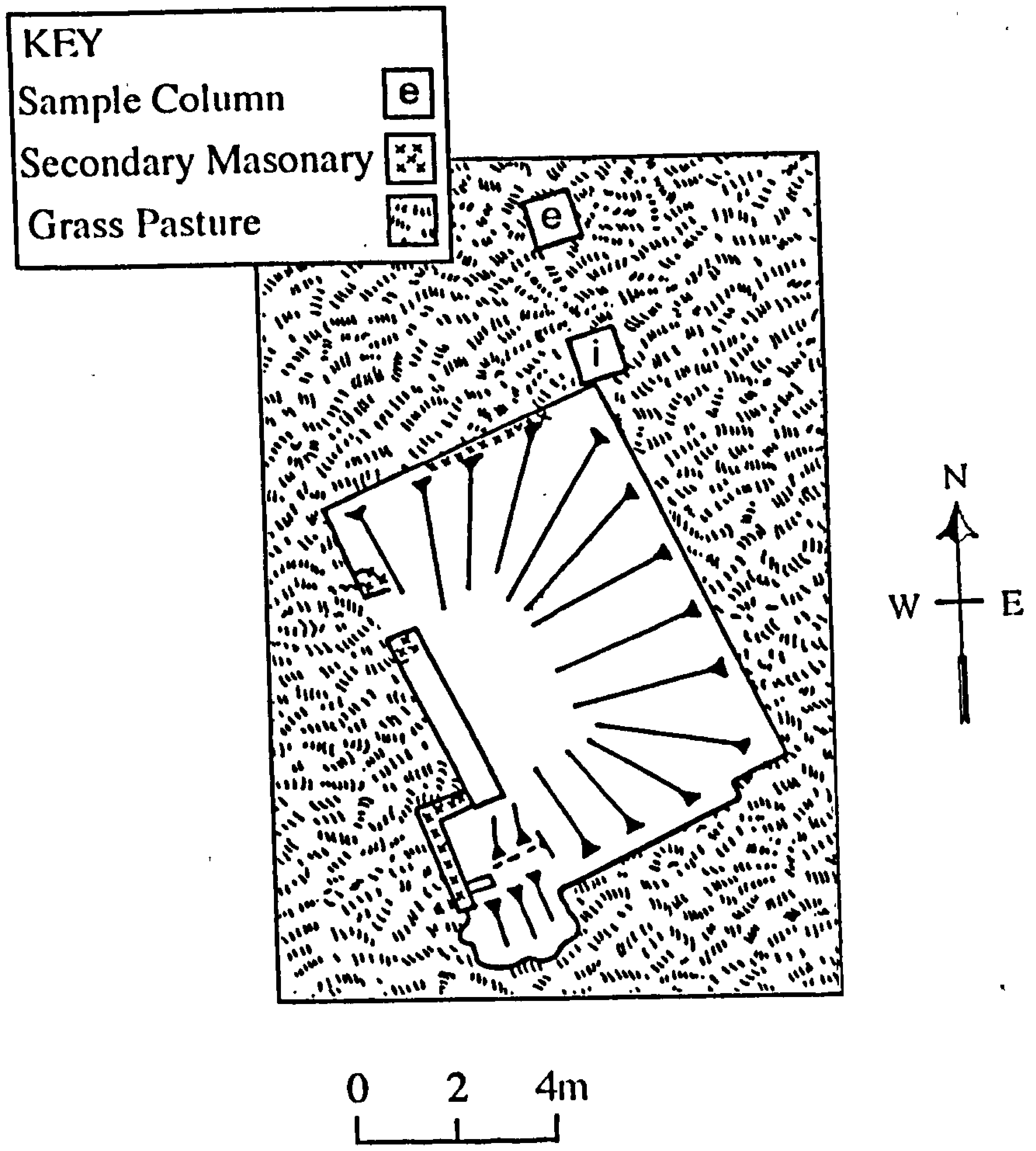


Figure 5.6. Robert's Haven, Area E

Robert's Haven 1993 Column C, Area A

Context Descriptions:

3002 Light brown medium sand

3003 Mid brown clay & sand with shell, bone & stone

3006 Dark brown/black (peaty) sandy clay with burnt peat, sand pockets, stone, shell & fish bone

3007 Light brown medium sand with shell, bone, burnt peat, pockets of sand & clay

3008 Mid brown sand & clay with shell & bone

3009 Mid brown clay & sand with shell, fish bone, burnt peat & stone

3010 Dark brown/black (peaty) sandy clay with burnt peat, stone, bird bone, shell & fish bone

3011 Dark brown/black (peaty) sandy clay with burnt peat, shell, fish bone and stone

3012 Dark brown (peaty) sandy clay with shell, fish bone, stone & burnt peat

3013 Mid brown clay & sand with stone, burnt peat, sand pockets, shell & fish bone

3014 Brownish grey clay & sand with burnt peat, brown clay patches, shell, fish bone & stone

3015 Light brownish grey clayey sand with shell, fish bone, stone & burnt peat

3016 Light brown sand

3017 Dark brown/black (peaty) sandy clay with burnt peat, brown clay patches, stones, shell & fish bone

3019 Mid brown clayey sand with shell, fish bone, stone & charcoal

3020 Light brown medium/coarse sand

Sterile calcareous sands

Sandy clays and sands with cultural inclusions

Peaty clays

Whelk shells

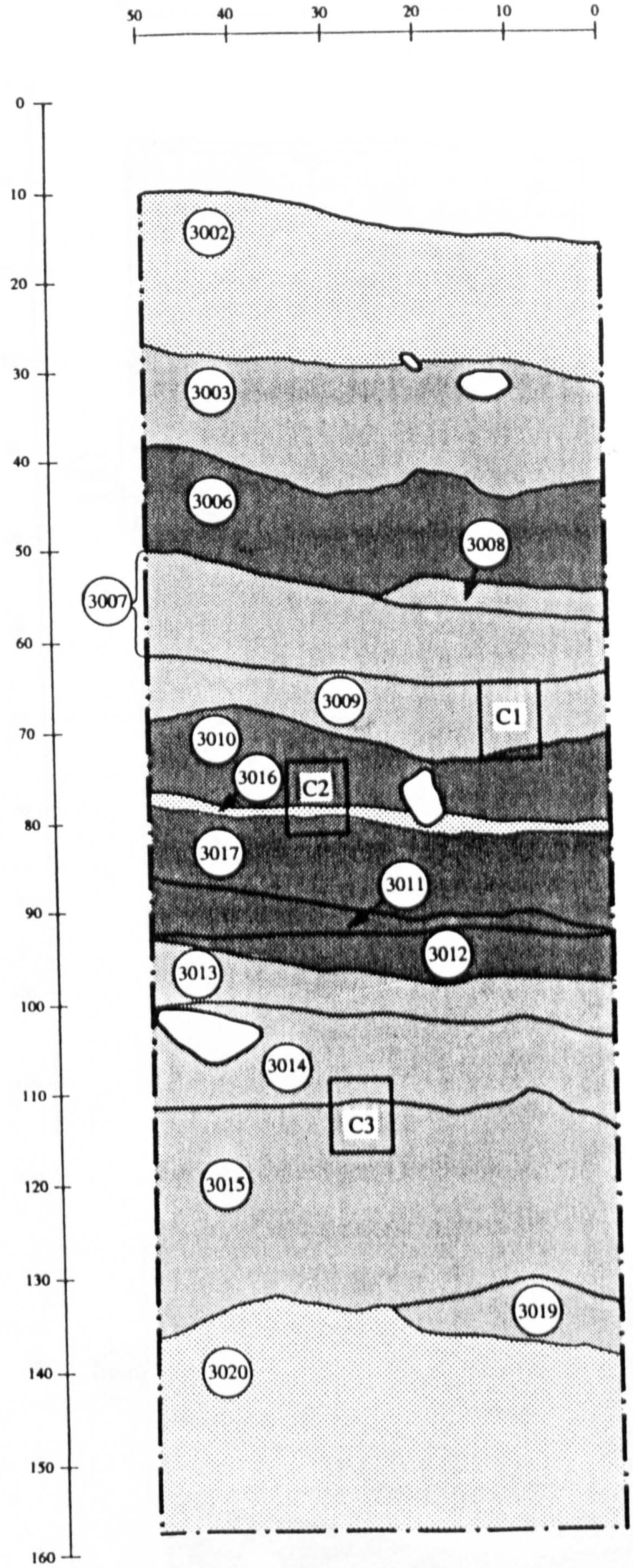


Figure 5.7. Robert's Haven, Column C, Area A (scale in cm).

Robert's Haven 1993 Column G, Area B

Context Descriptions:

7002 Loose pale to mid grey brown sand

7003 Dark grey coarse sand with pale mottles, greasy clay patches and occasional fish bone

7004 Pale brown to grey coarse sand with shell, fish bone, bird bone and mortar

7005 Compact/plastic black fine greasy material (peaty clay) with occasional shell, fish bone, mammal bone, bird bone, small stones and sand

7006 Loose pale brown to dirty grey coarse sand

7007 Compact black fine greasy material (peaty clay) with occasional fish bone, shell fragments, small stones, sand and mortar

7008 Very compact/plastic black fine peaty clay with occasional fish bones and shell fragments

7009 Loose pale brownish yellow coarse sand

7010 Firm/plastic black fine material (peaty clay) with occasional shell fragments, fish bone, stone and sand

7011 Loose dirty grey brown sand with black clayey midden patches, bone and shell fragments

7014 Loose pale brown coarse sand with grey clayey sand patches, occasional bone and peaty lumps

7017 Moderately loose dark grey coarse clayey sand with occasional fish bone, shell, peaty lumps and small angular stones

7018 Very loose pale brown coarse sand with occasional dark grey clayey patches

7019 Moderately compact and greasy dark greyish brown coarse clayey sand with occasional fish bone, shell and small stones

7020 Loose pale yellow with black to dark grey clay patches and lenses (excavated as separate samples in some cases) and whelks

7021 Firm black plastic peaty clay with orange and grey-green patches, fish bone, sand, charcoal, mortar, pottery and stones

7022 Moderate dark greyish brown fine sand and greasy clay with occasional shell, small stones, fish bone and mammal bone

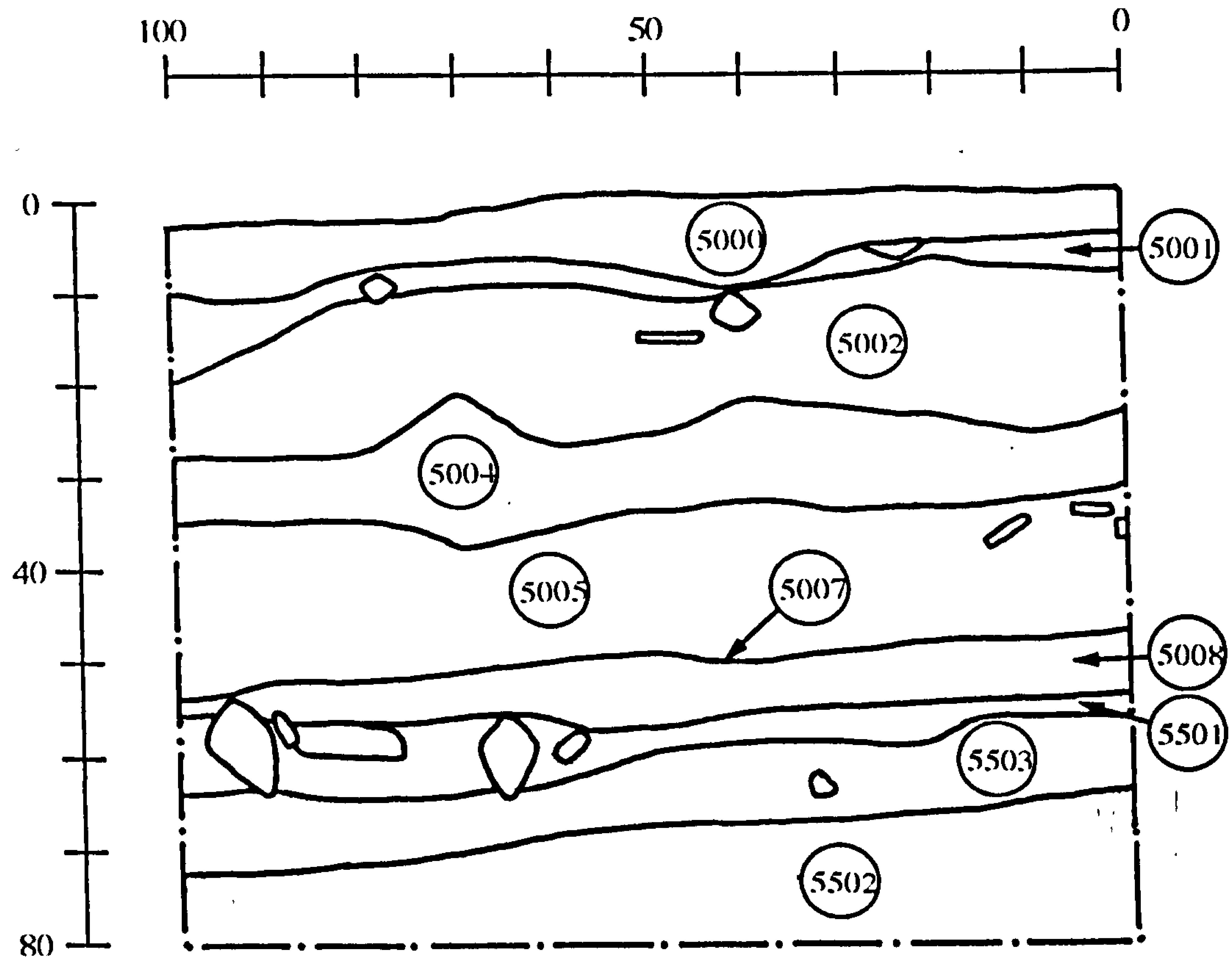
Sterile calcareous sands

Sandy clays and sands with cultural inclusions

Peaty clays

Whelk shells

Figure 5.8. Robert's Haven, Column G, Area B (scale in cm).



Context	Description
5000	Turf
5001	Beige coarse sand
5002	Brown sandy loam with stones, shell, pottery and bone
5004	Dark brown sandy loam with stones and pottery
5005	Dark brown sandy loam with stones, shell, bone and pottery
5007	Sand lens
5008/5500	Black peaty clay with shells
5501	Dark brown clay with frequent stones
5502	Light grayish brown clay
5503	Medium brown clay

Figure 5.9. Robert's Haven, Columns E, Area E (scale in cm).

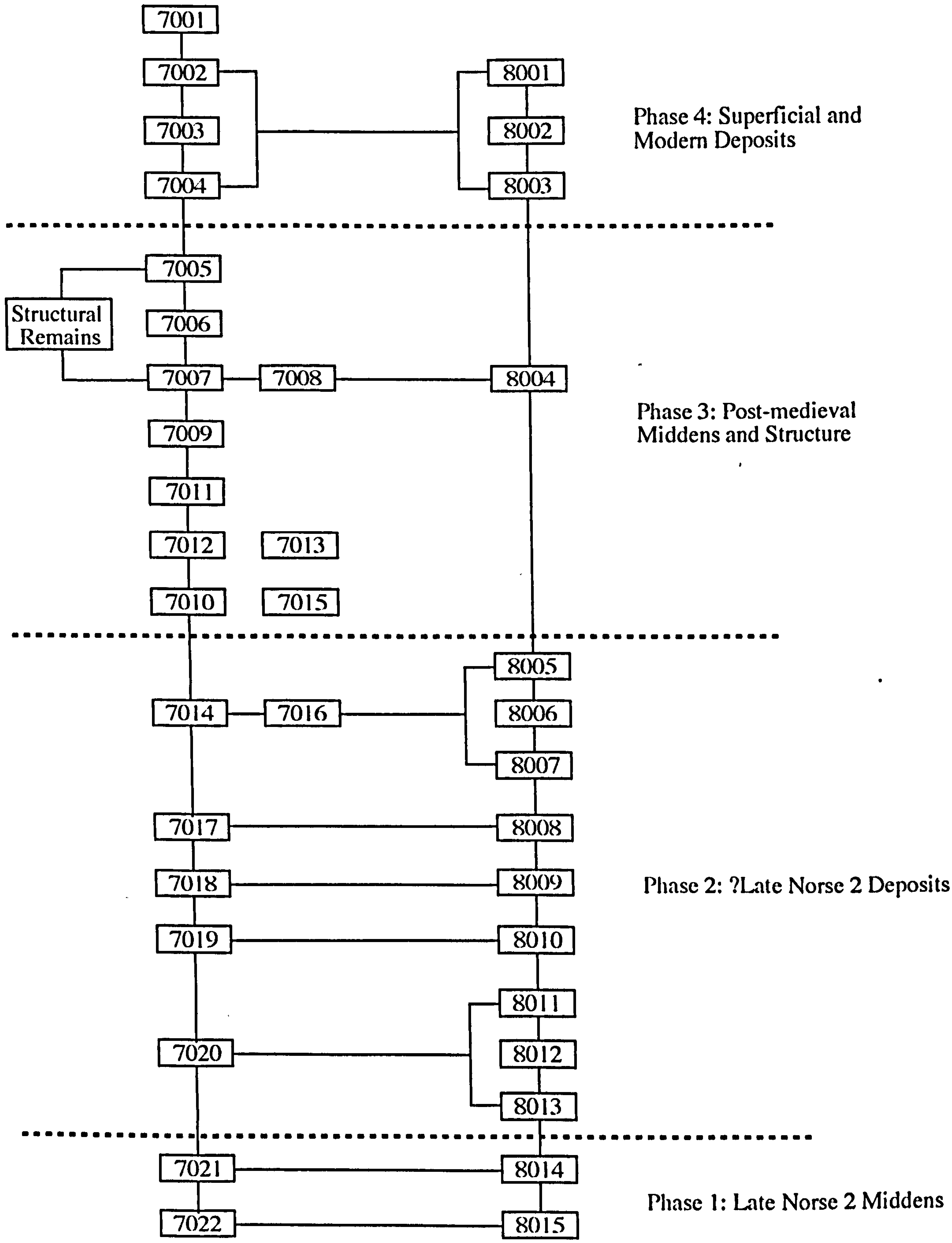


Figure 5.10. Robert's Haven, stratigraphic matrix and phasing of Area B

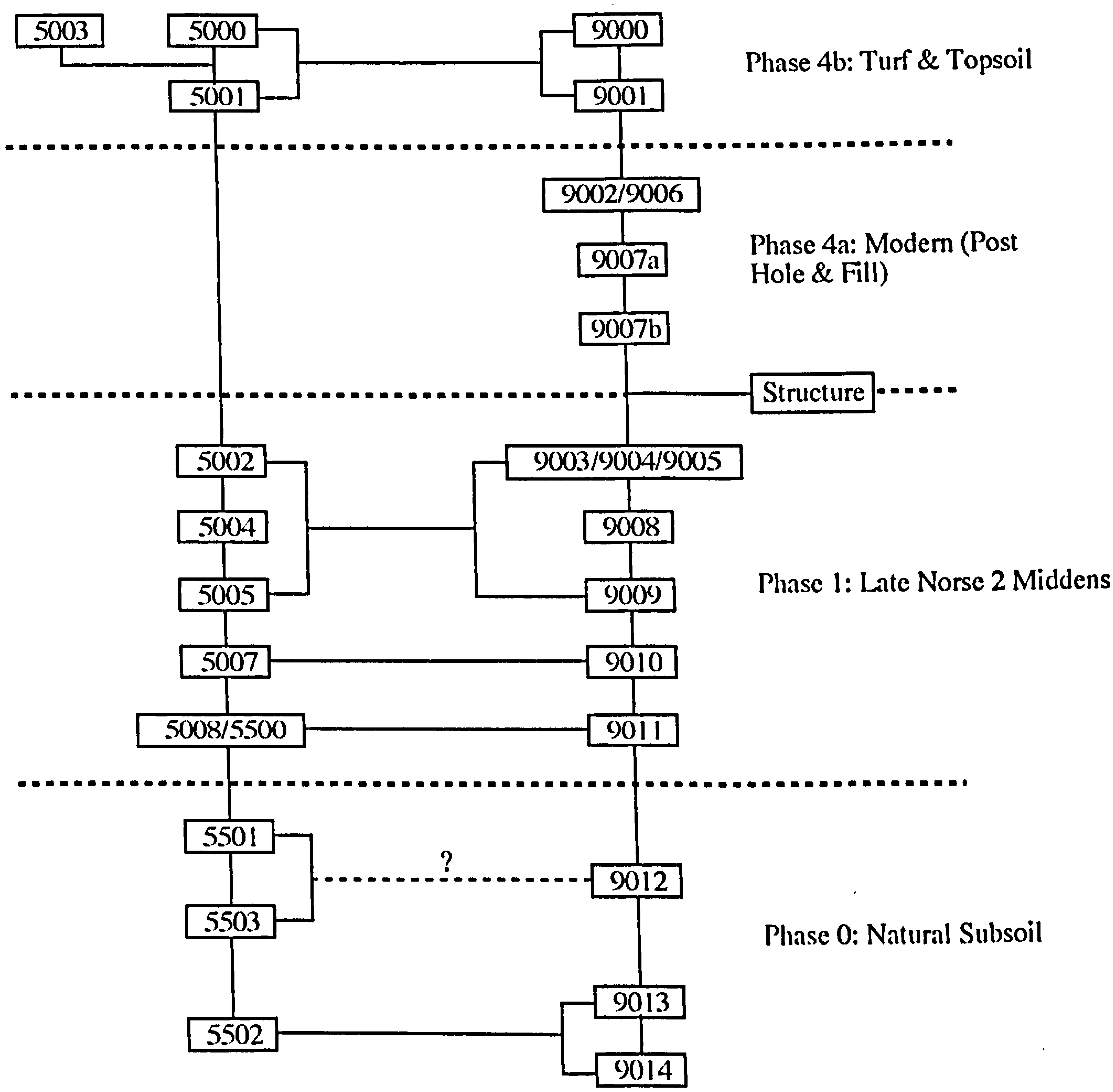


Figure 5.11. Robert's Haven, stratigraphic matrix and phasing of Area E

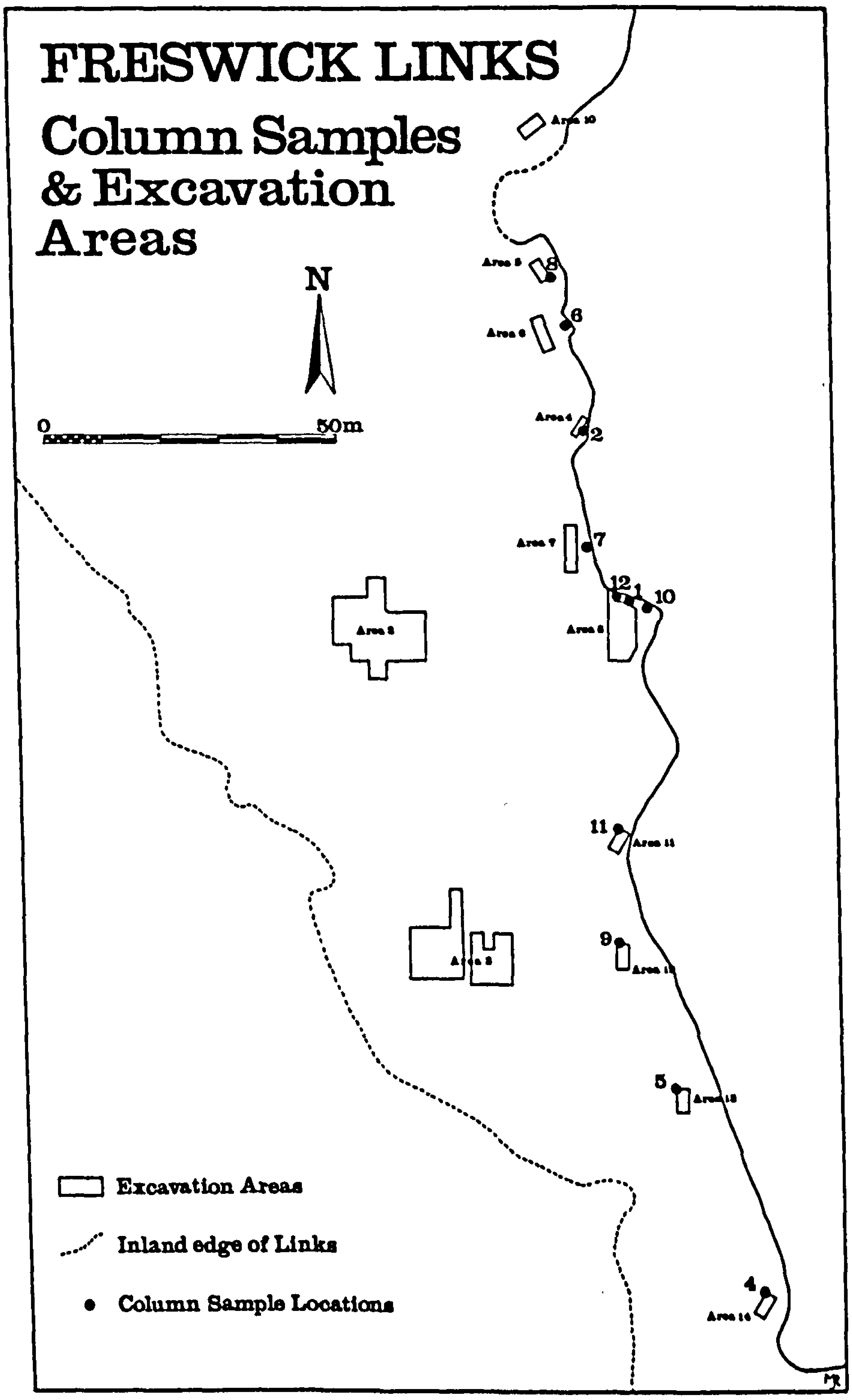
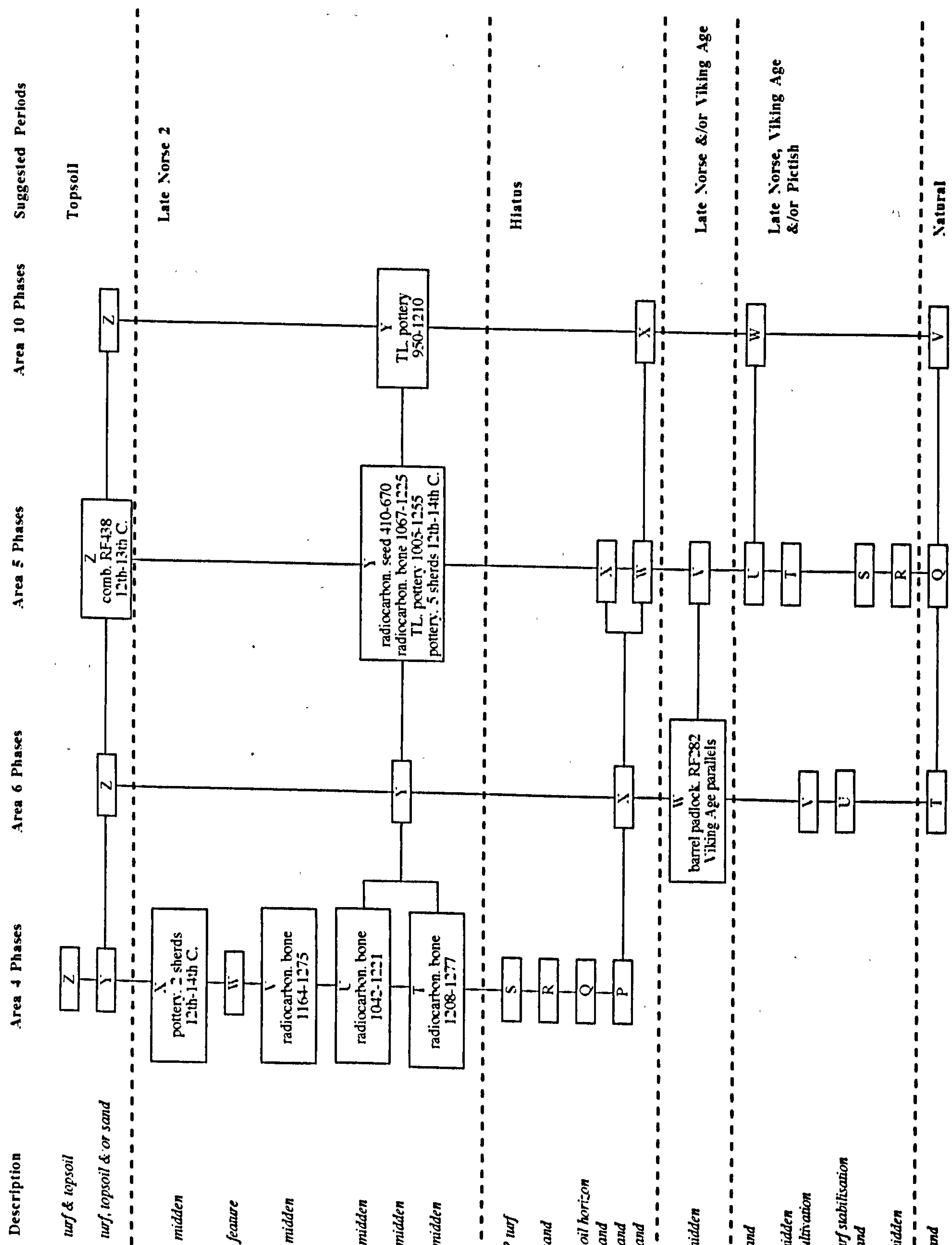
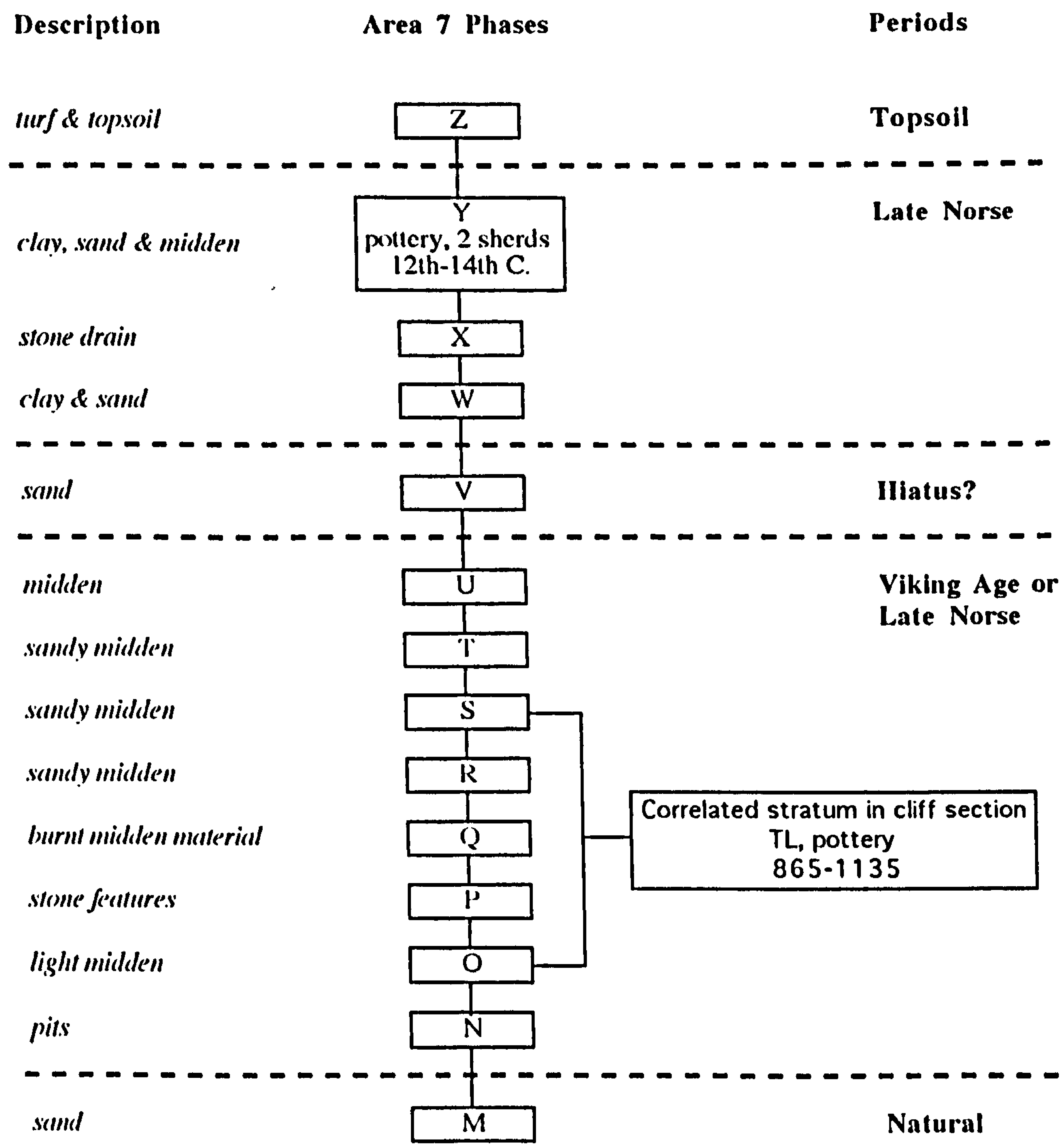


Figure 5.12. Freswick Links Project Map (from Morris et al. 1992:45)



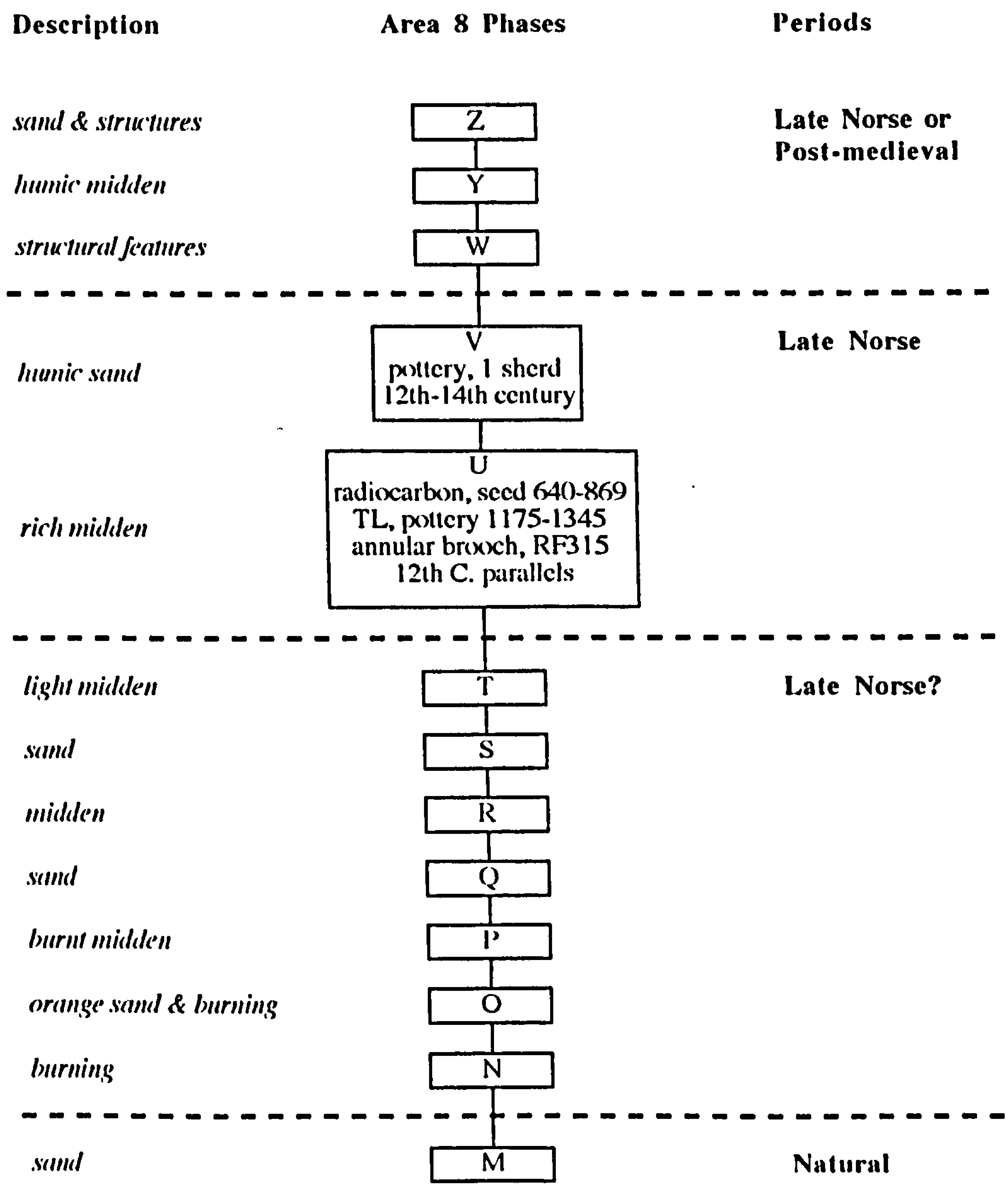
Notes: Radiocarbon assays given in calibrated years A.D. (1 sigma range). TL =thermoluminescence. C. = century. Artifact numbers refer to Batey et al.

Figure 5.13. Freswick Links, Northern Cliff Areas, chronological interpretation used in this study (based on data from Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris forthcoming b; Morris & Cook forthcoming; Morris et al. forthcoming b).



Notes: Radiocarbon assays given in calibrated years A.D. (1 sigma range). TL =thermoluminescence. C. = century. Artifact numbers refer to Batey et al. forthcoming a.

Figure 5.14. Freswick Links, Middle Cliff Areas, Area 7, chronological interpretation used in this study (based on data from Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris & Cook forthcoming; Morris et al. forthcoming b; Rains & Morris forthcoming).



Notes: Radiocarbon assays given in calibrated years A.D. (1 sigma range). TL =thermoluminescence.
C. = century. Artifact numbers refer to Batey et al. forthcoming a.

Figure 5.15. Freswick Links, Middle Cliff Areas, Area 8, chronological interpretation used in this study (based on data from Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris & Cook forthcoming; Morris et al. forthcoming b; Rains & Morris forthcoming).

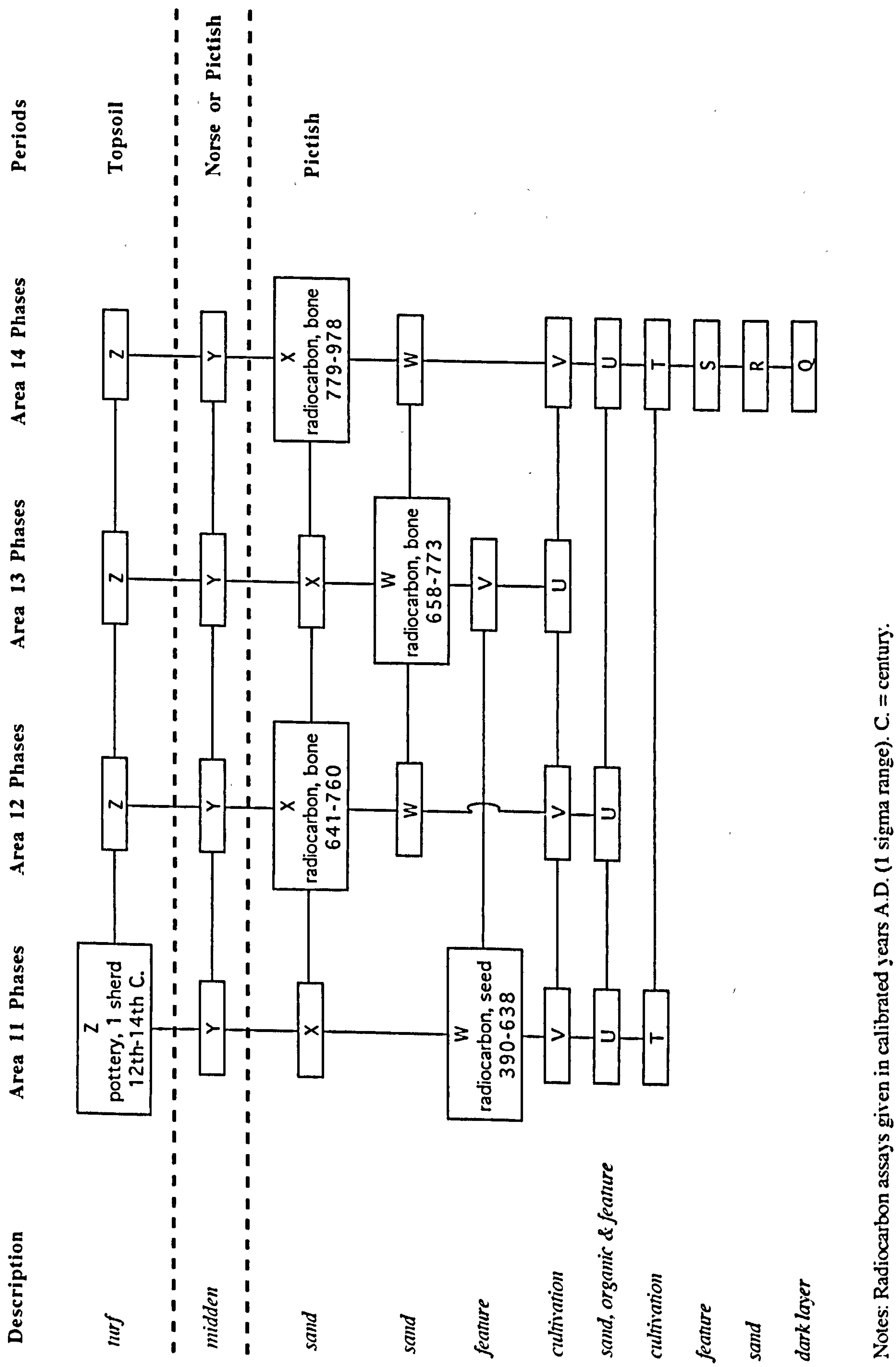
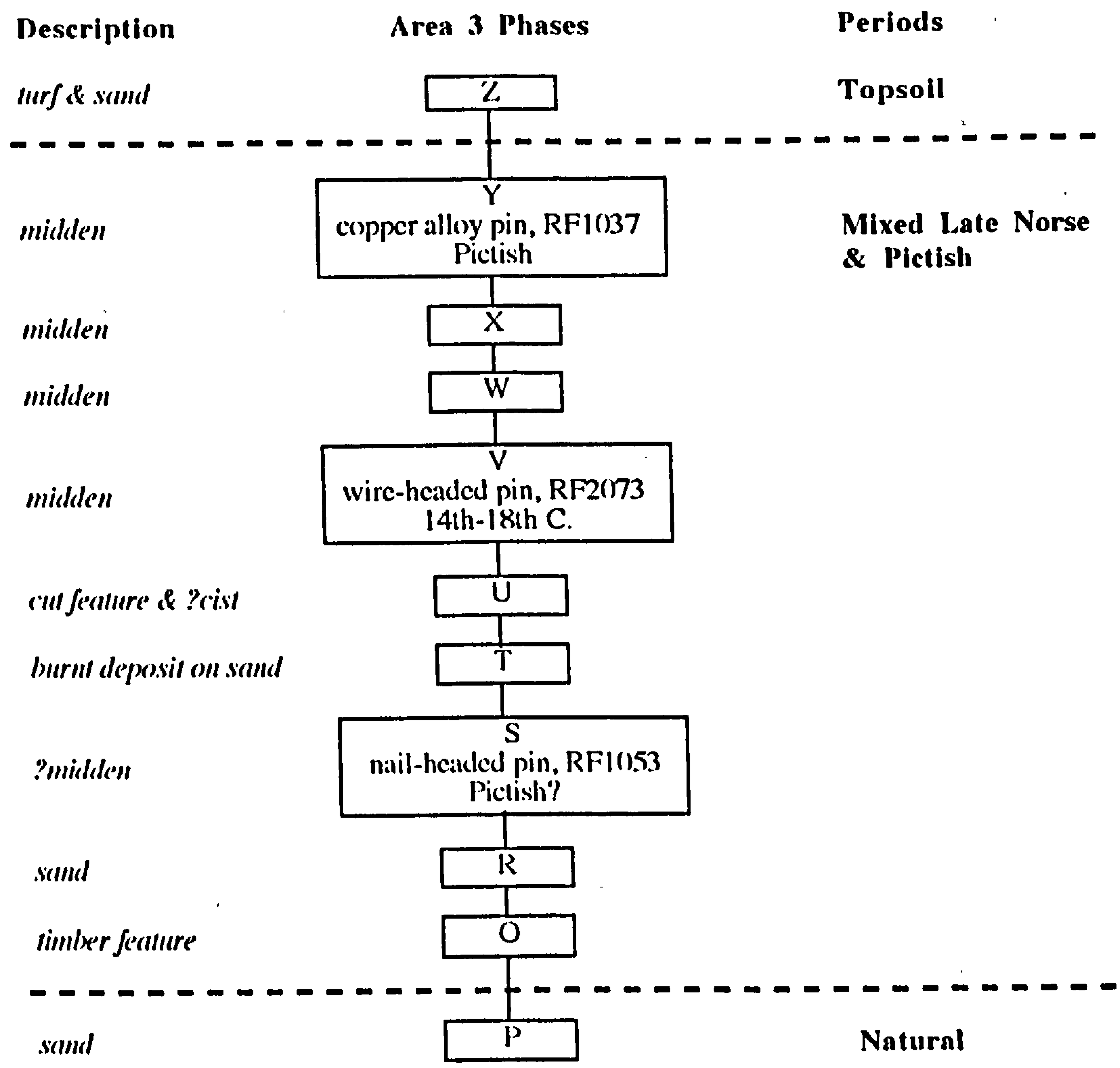


Figure 5.16. Freswick Links, Southern Cliff Areas, chronological interpretation used in this study (based on data from Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris forthcoming c; Morris & Cook forthcoming; Morris et al. forthcoming b).



Note. Artifact numbers refer to
Batey et al. forthcoming a.

Figure 5.17. Freswick Links, Area 3, chronological interpretation used in this study (based on data from Alvey et al. forthcoming; Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris & Cook forthcoming; Morris et al. forthcoming b).

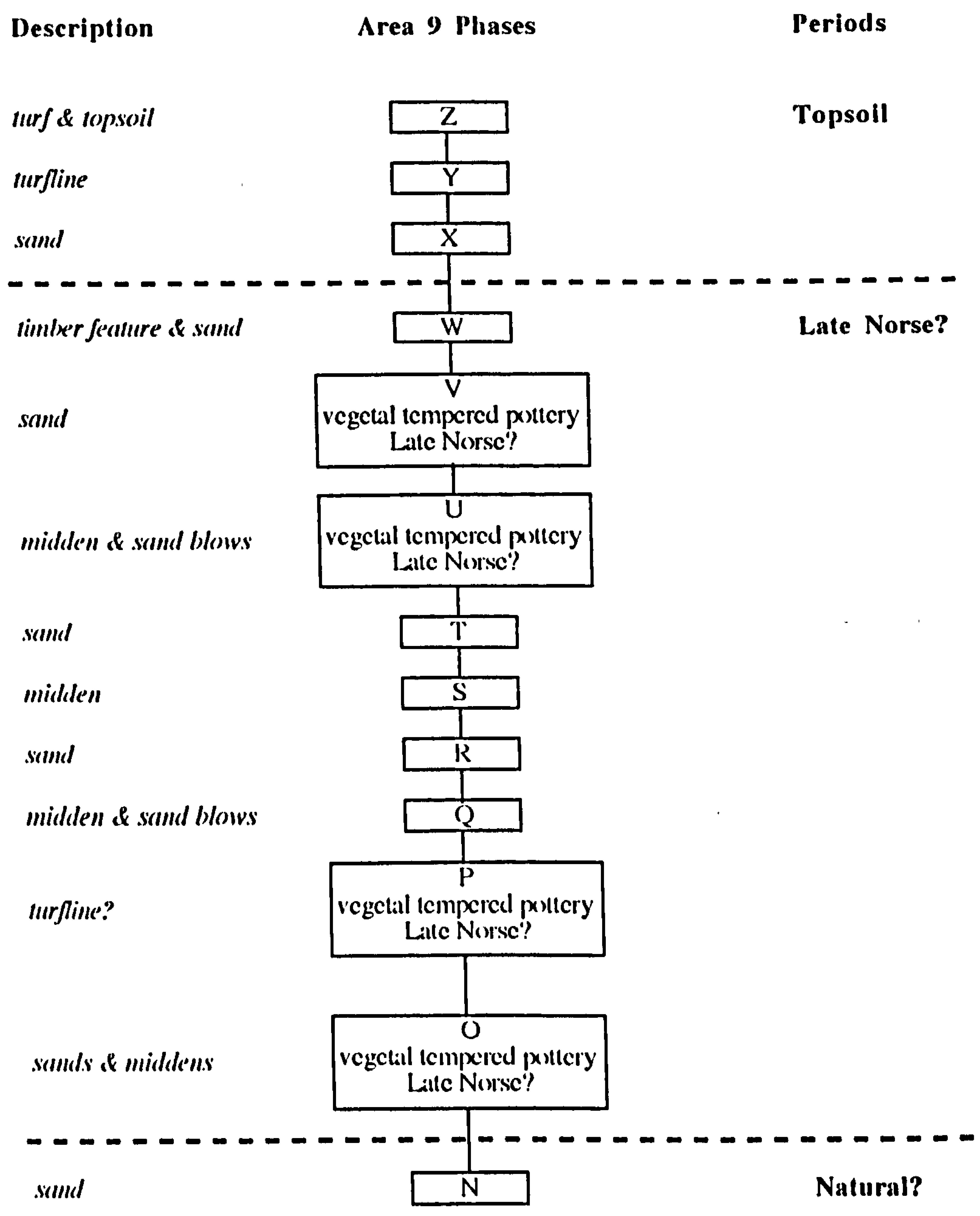


Figure 5.18. Freswick Links, Area 9, chronological interpretation used in this study (based on data from Alvey et al. forthcoming; Batey et al. forthcoming a; Gaimster & Batey forthcoming; Morris & Cook forthcoming; Morris et al. forthcoming b).

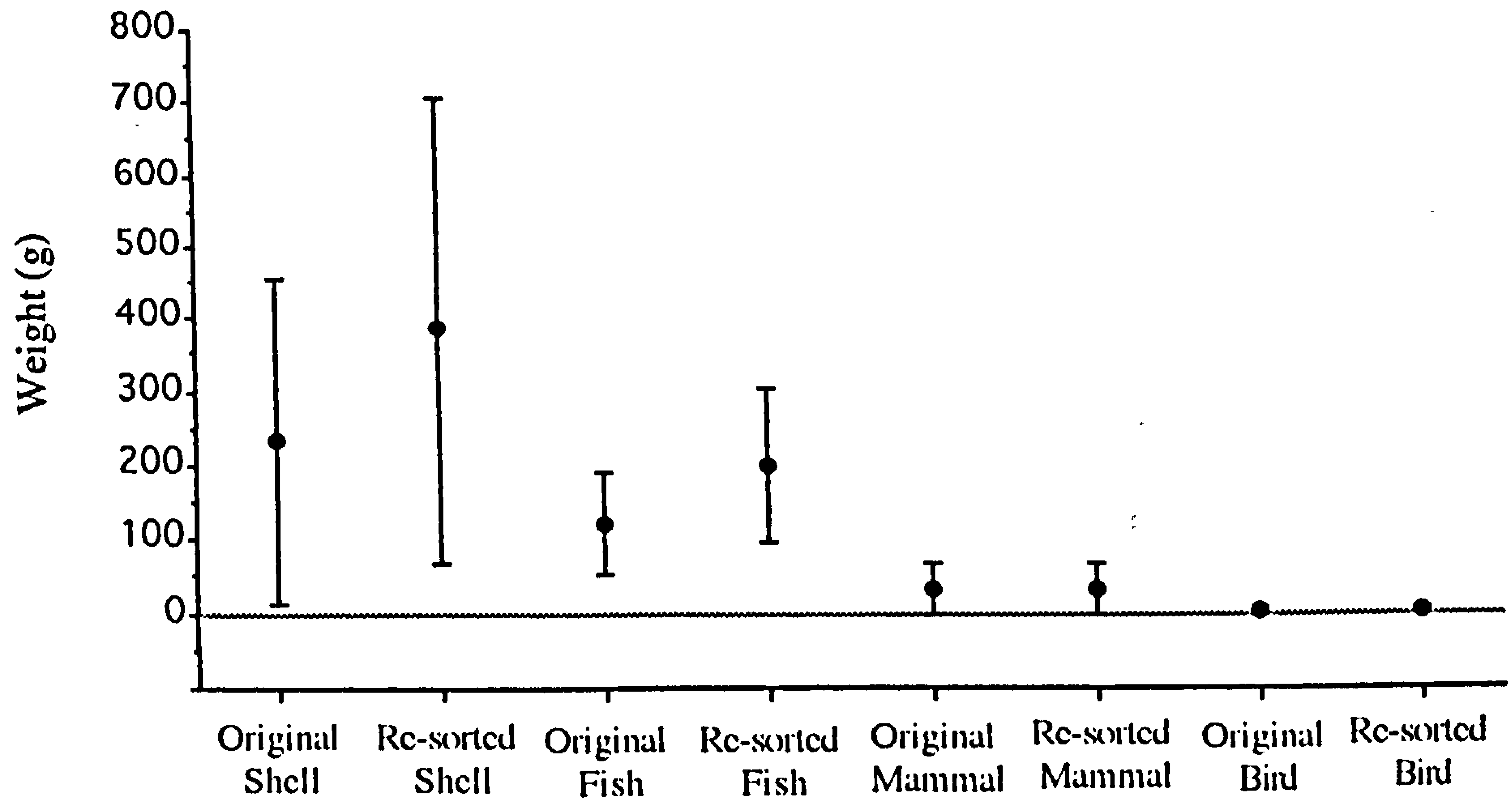


Figure 5.19. Freswick Links, A comparison of the shell and bone content (by weight) of 47 samples from Freswick Links NCA (Area 4) sorted by Jones' method (Jones et al. forthcoming a) and completely sorted to 4mm under the author's direction.

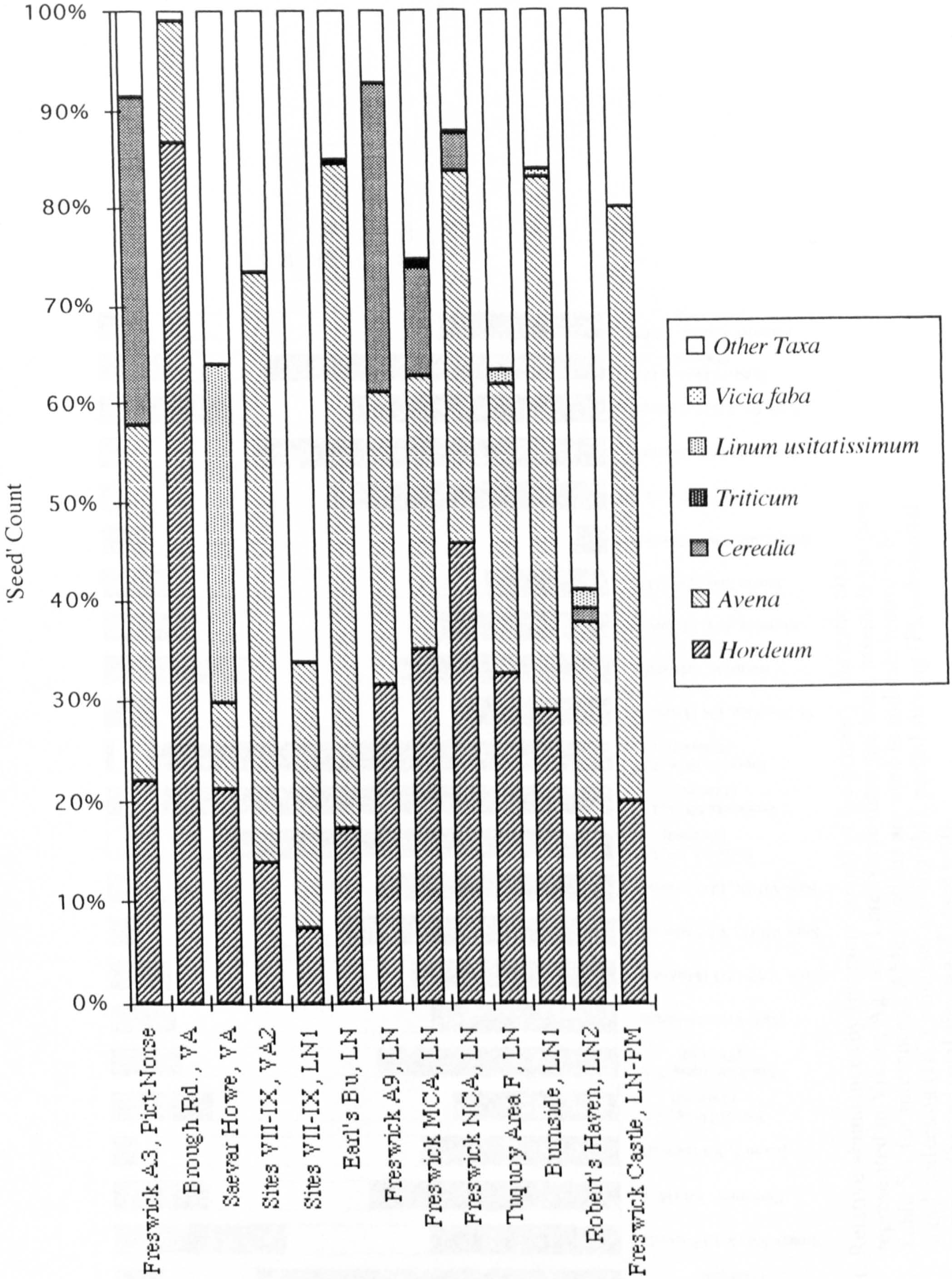


Figure 5.20. Relative abundance (by seed count) of the primary economic taxa represented in Viking Age and Late Norse botanical assemblages - carbonised material only (see Table 5.2 for references).

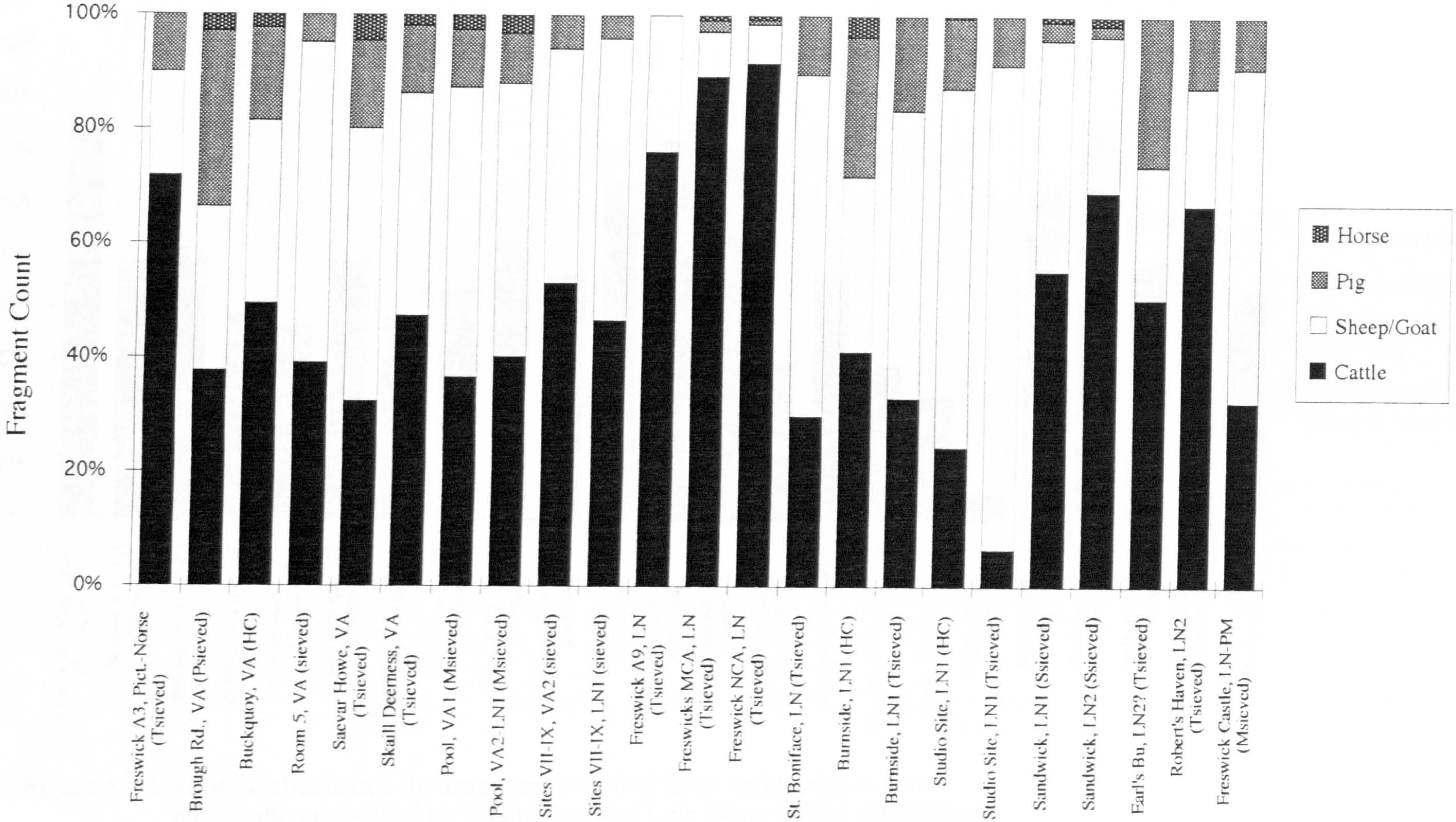


Figure 5.21. Relative abundance (by fragment count) of the primary domestic taxa represented in Viking Age and Late Norse mammal bone assemblages (see Table 5.1 for references). Abbreviations are used to indicate recovery by hand collecting (HC), minimal sieving (M), partial sieving (P), substantial sieving (S) and total sieving (T) (see text).

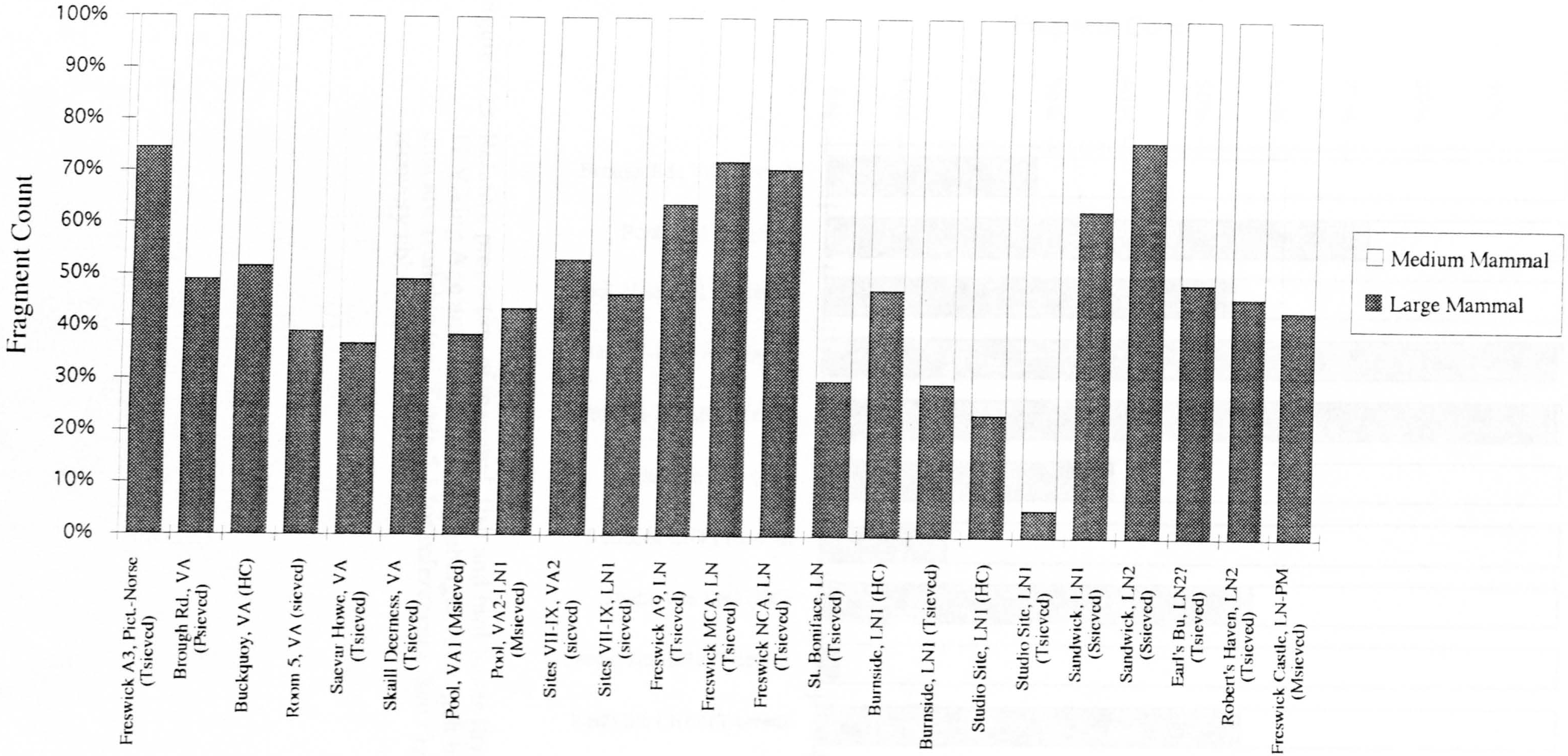


Figure 5.22. Relative abundance (by fragment count) of large and medium sized mammals represented in Viking Age and Late Norse faunal assemblages (see Table 5.1 for references). "Large" includes the categories cattle, horse, large hoofed mammal and large mammal. "Medium" includes the categories sheep/goat, sheep, goat, pig, small hoofed mammal and medium mammal. See Figure 5.21 for key to recovery abbreviations.

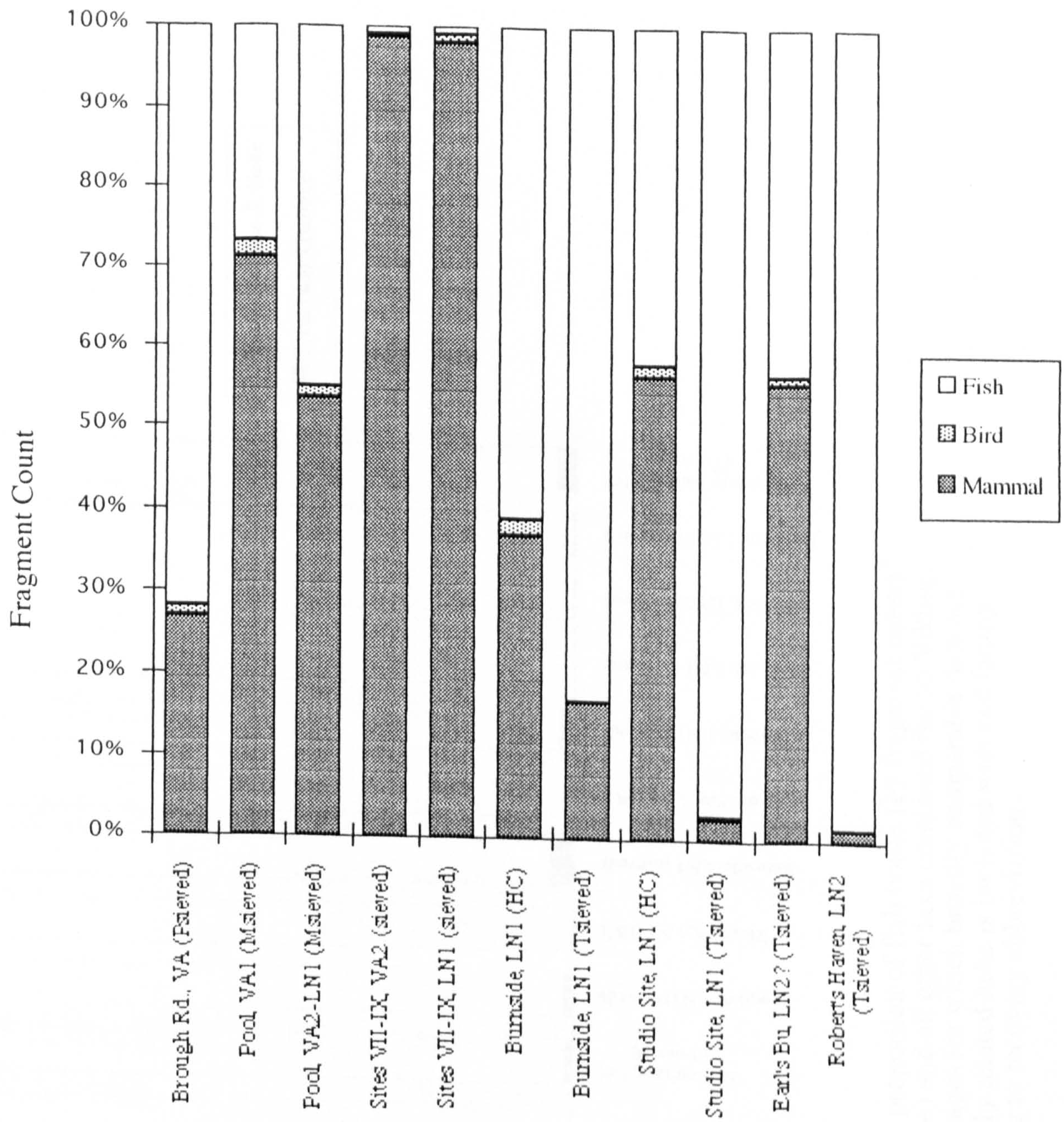


Figure 5.23. Relative proportion of mammal, fish and bird bones (by fragment count) in 11 Viking Age and Late Norse assemblages for which broadly comparable data are available (see Table 5.1 for references). See Figure 5.21 for key to recovery abbreviations.

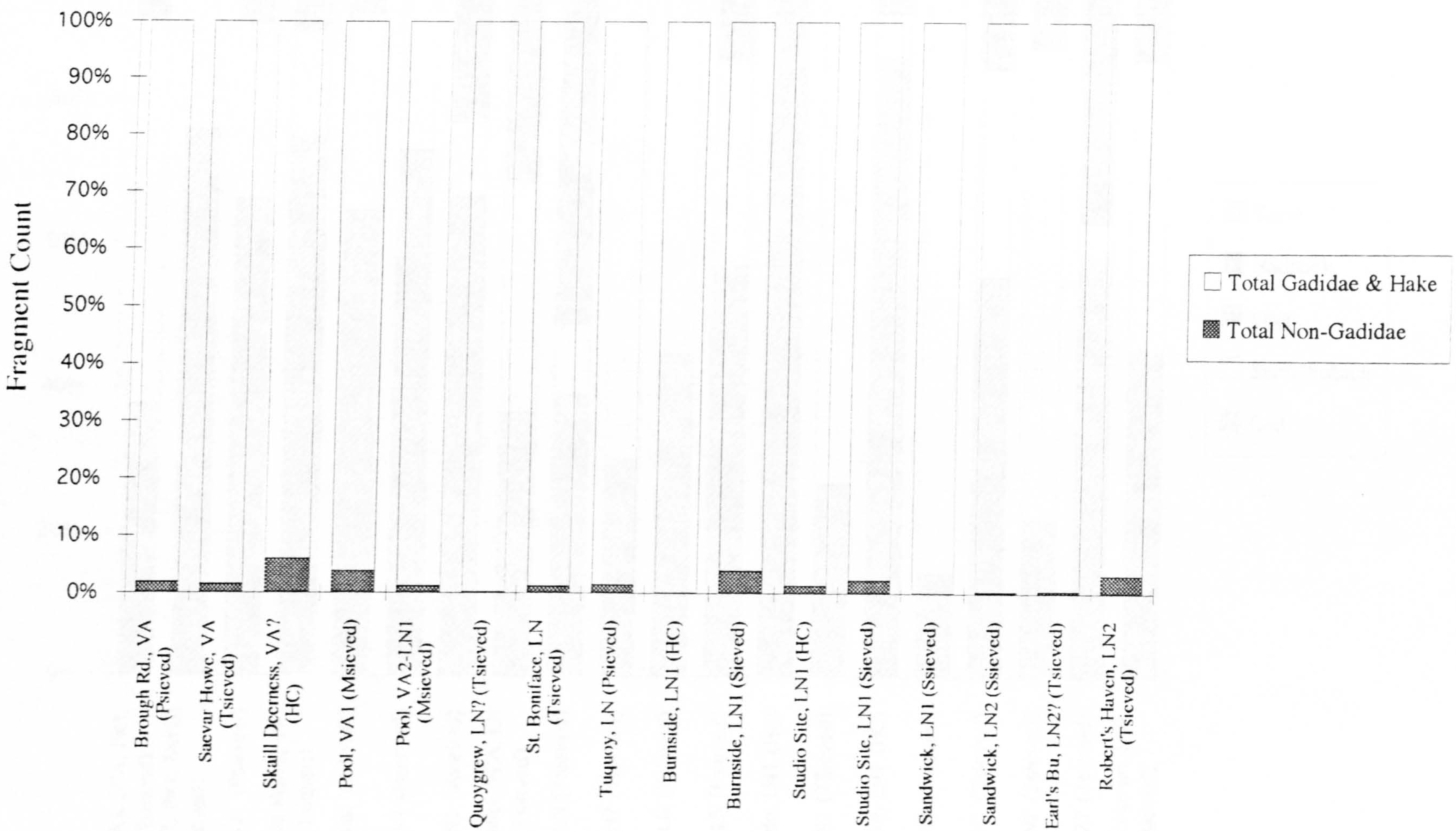


Figure 5.24. A comparison of the relative proportion of fish bones (by fragment count) from the cod family (Gadidae) and all other taxa combined for 16 Viking Age and Late Norse assemblages for which broadly comparable data are available (note that the closely related hake is included with cod family fish). See Figure 5.21 for key to recovery abbreviations.

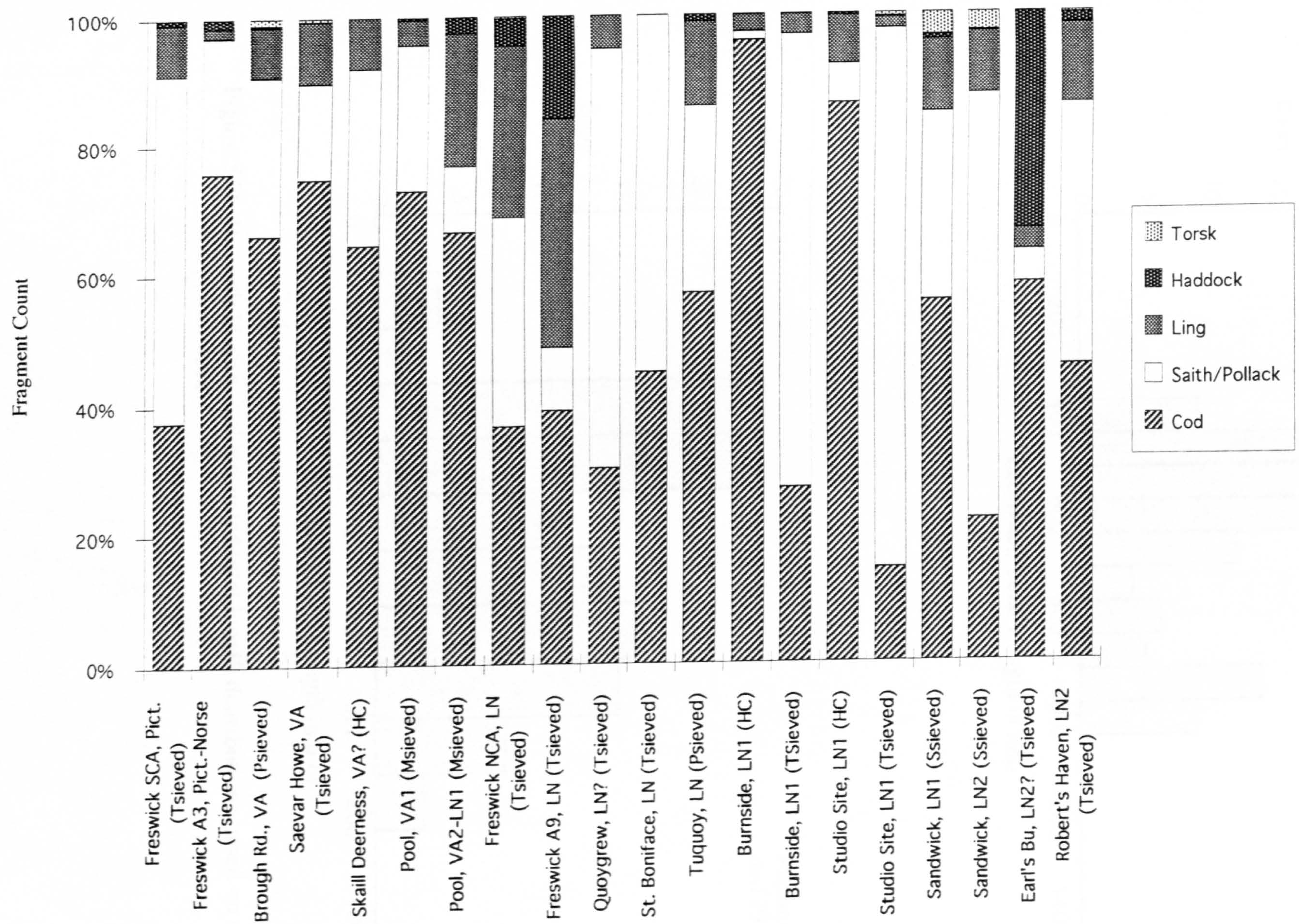
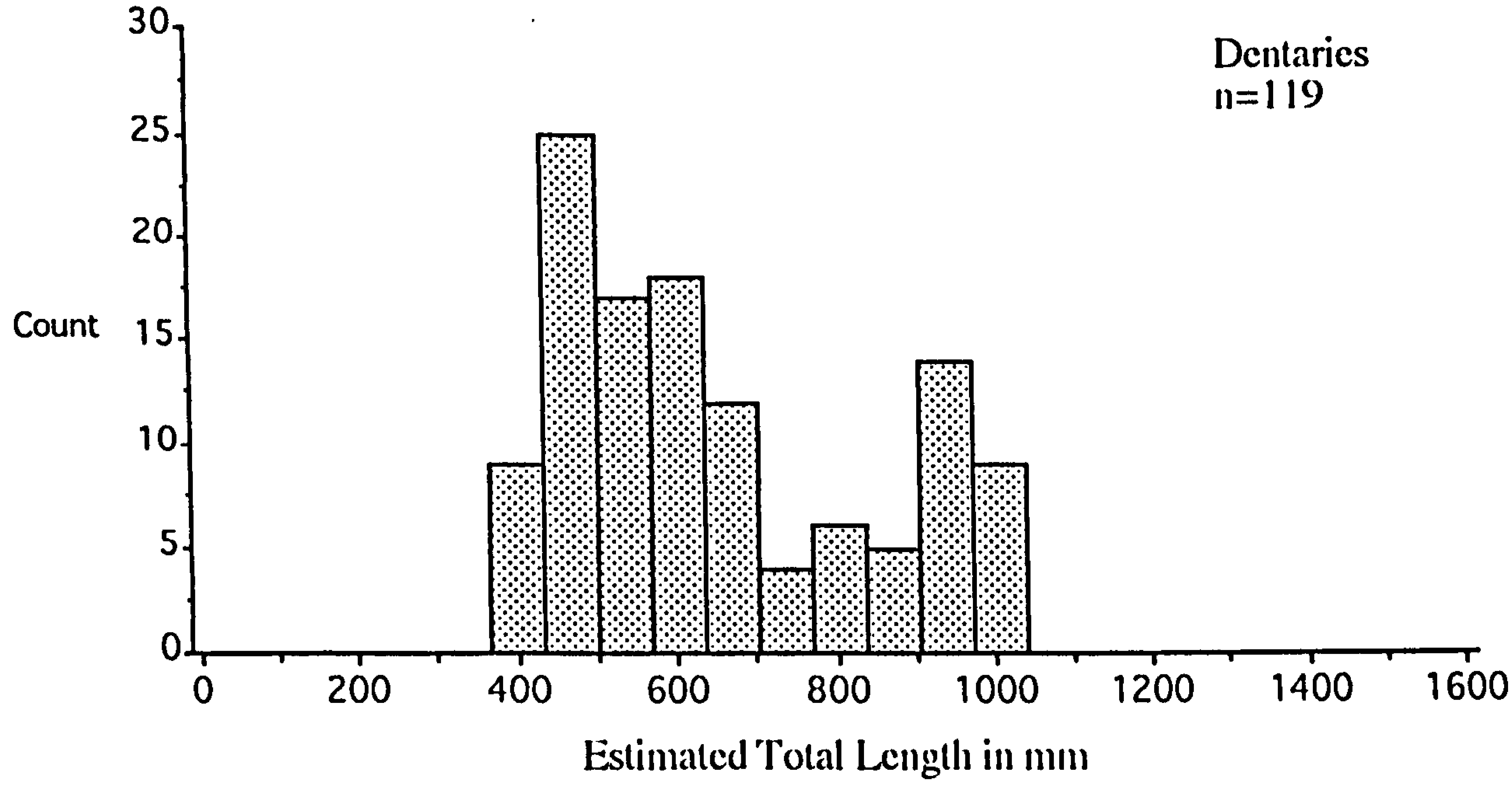


Figure 5.25. Relative abundance (by fragment count) of the primary cod family taxa represented in Viking Age and Late Norse fish bone assemblages. See Figure 5.21 for key to recovery abbreviations.



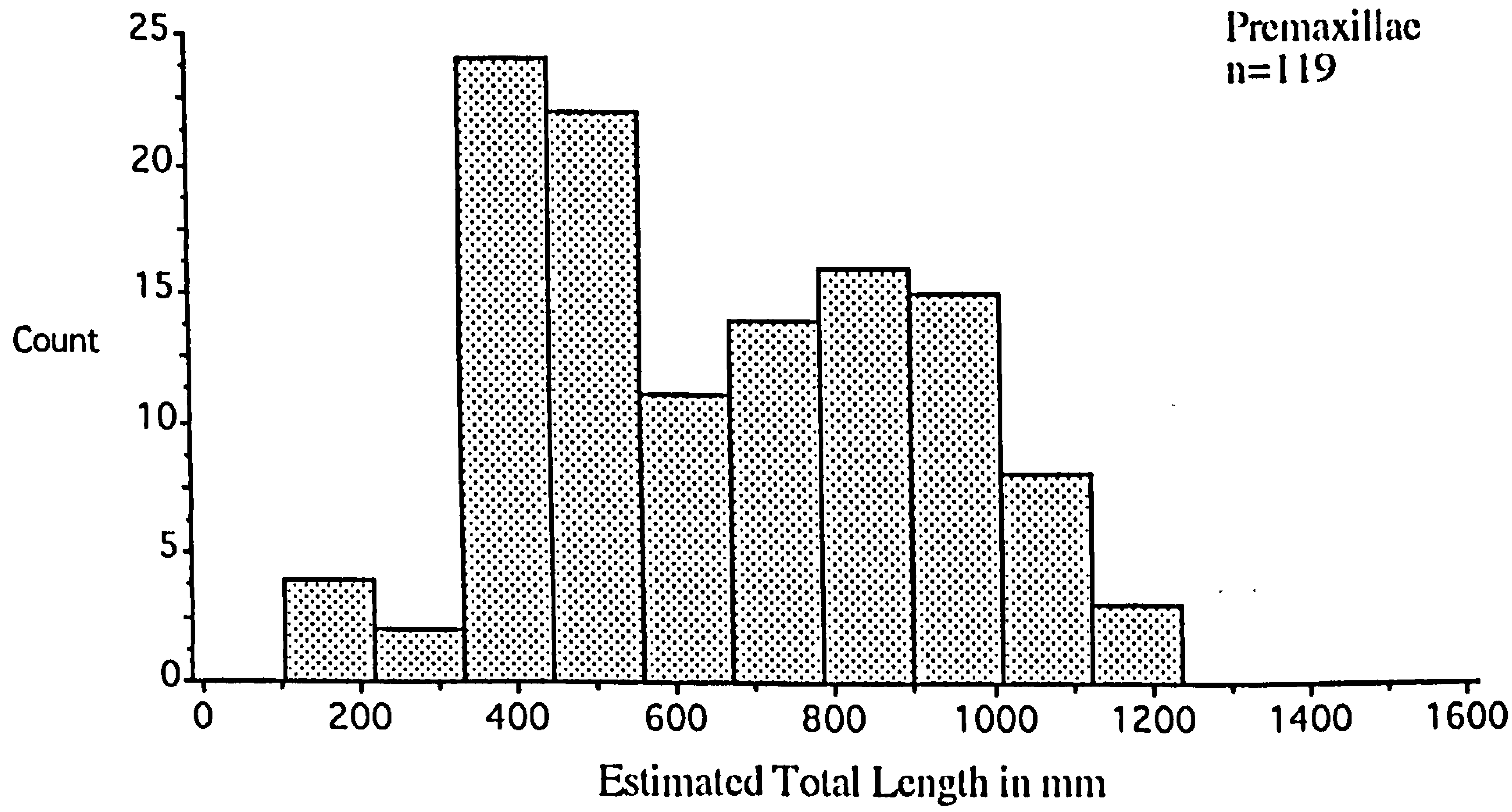


Figure 5.26. Robert's Haven, cod estimated total length distributions based on dentaries and premaxillae.

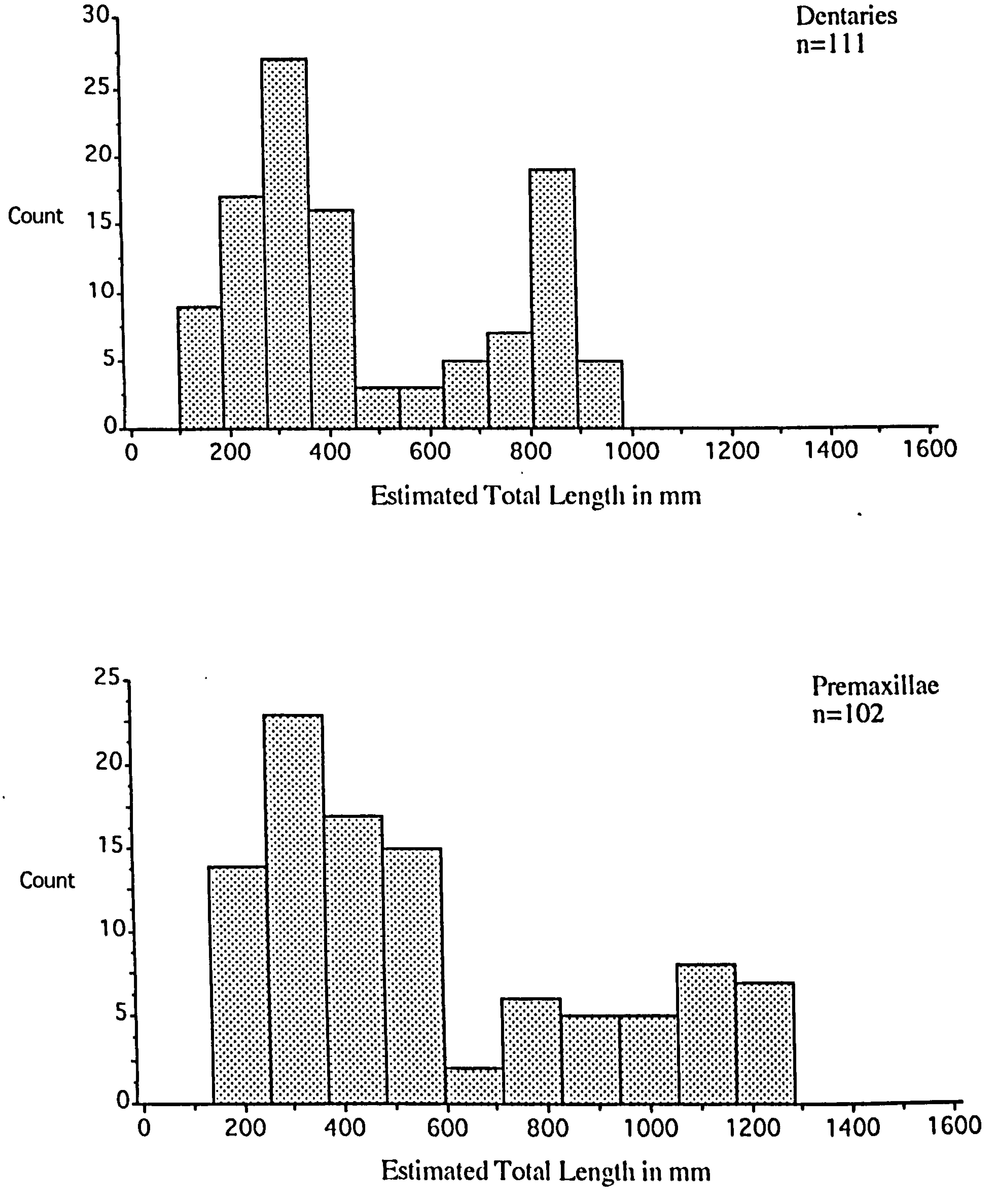
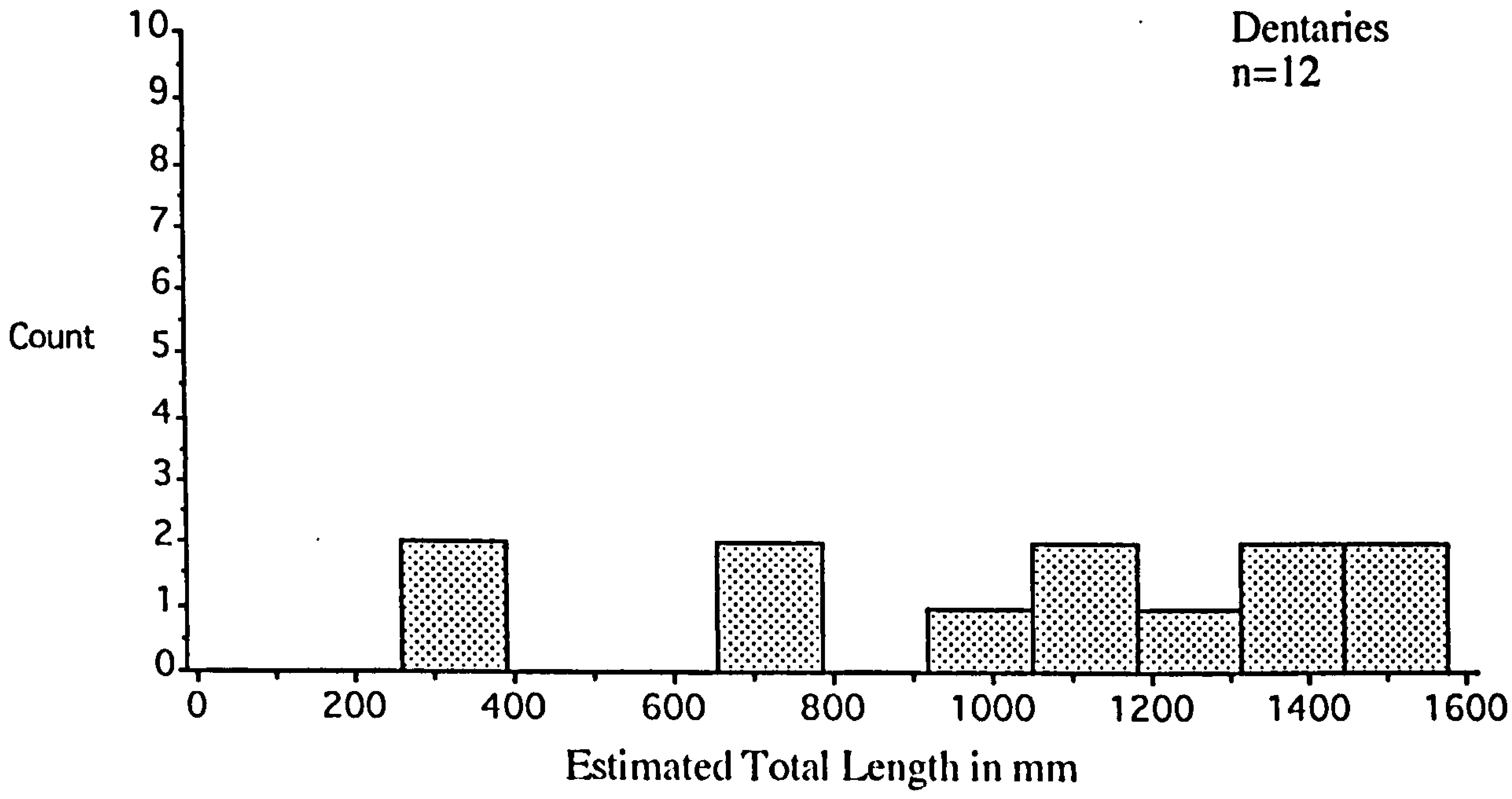


Figure 5.27. Robert's Haven, saith estimated total length distributions based on dentaries and premaxillae.



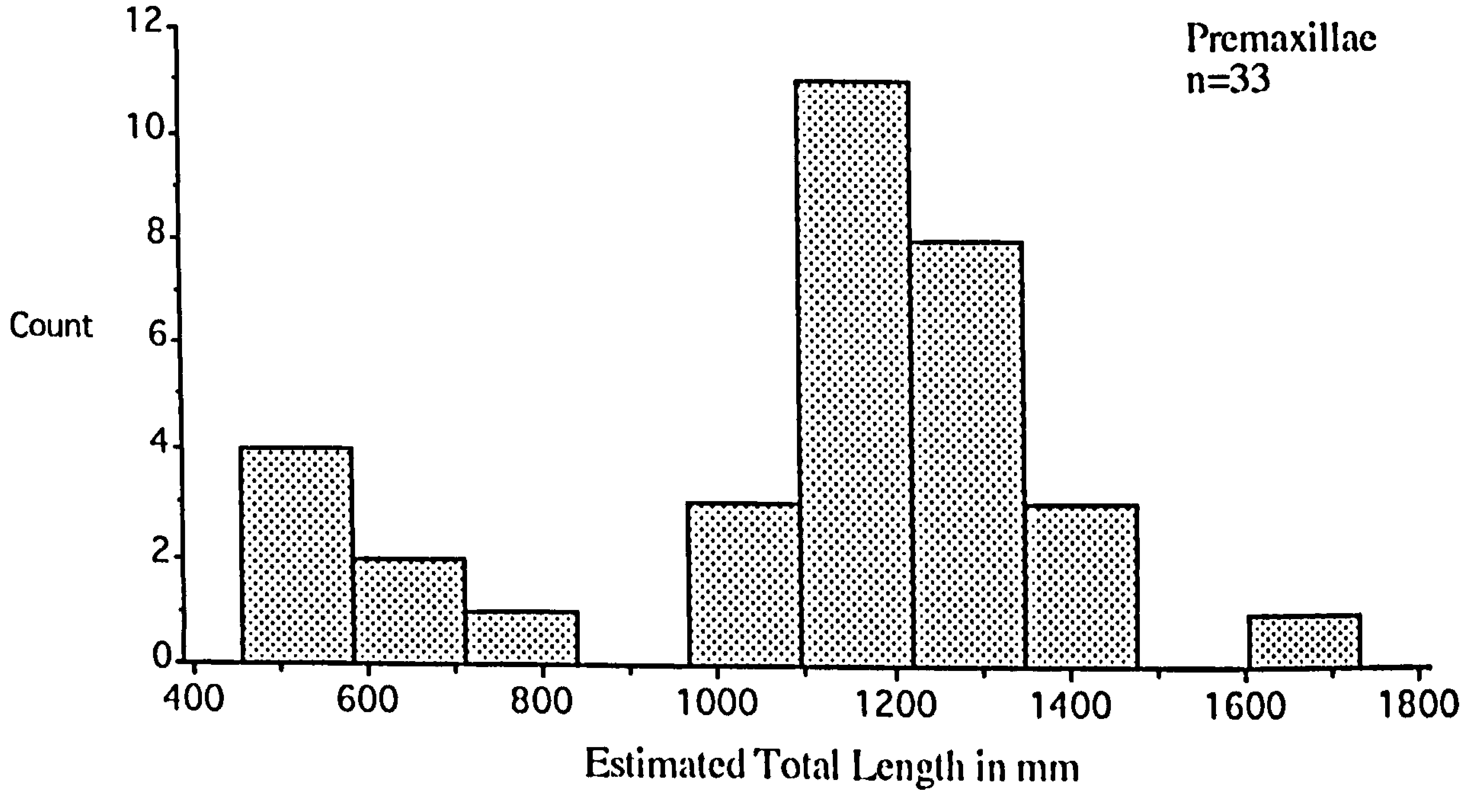
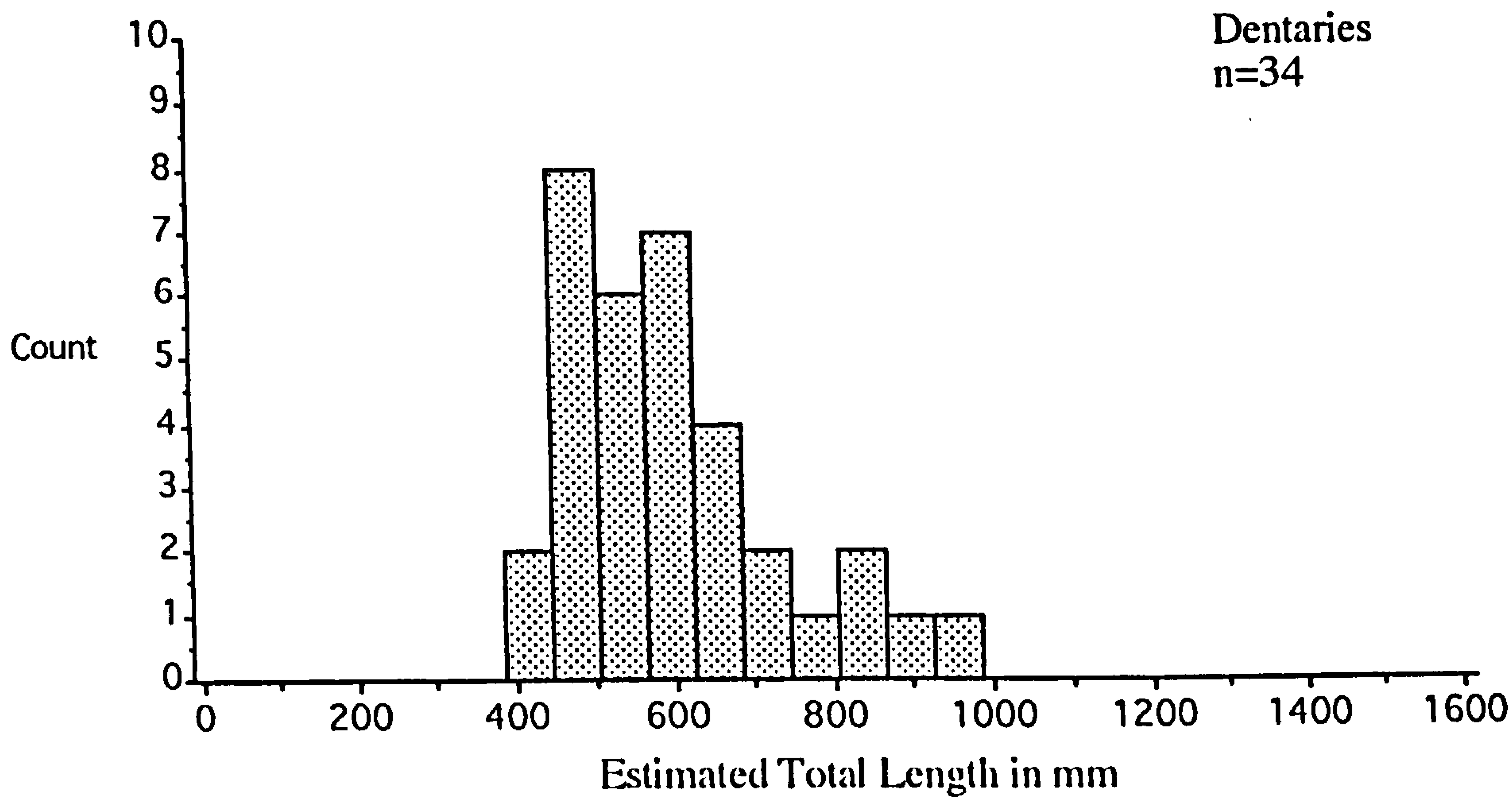


Figure 5.28. Robert's Haven, ling estimated total length distributions based on dentaries and premaxillae.



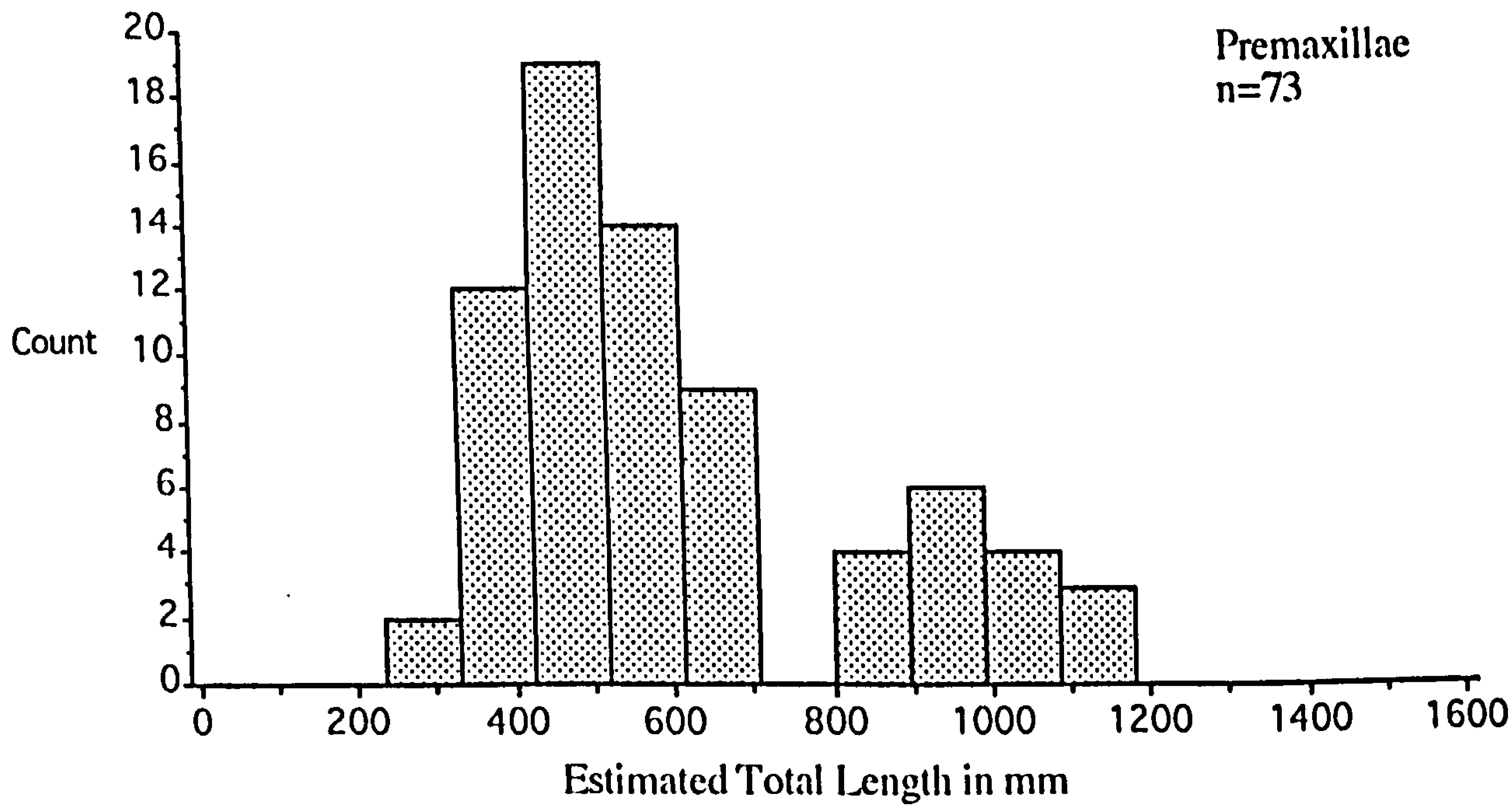
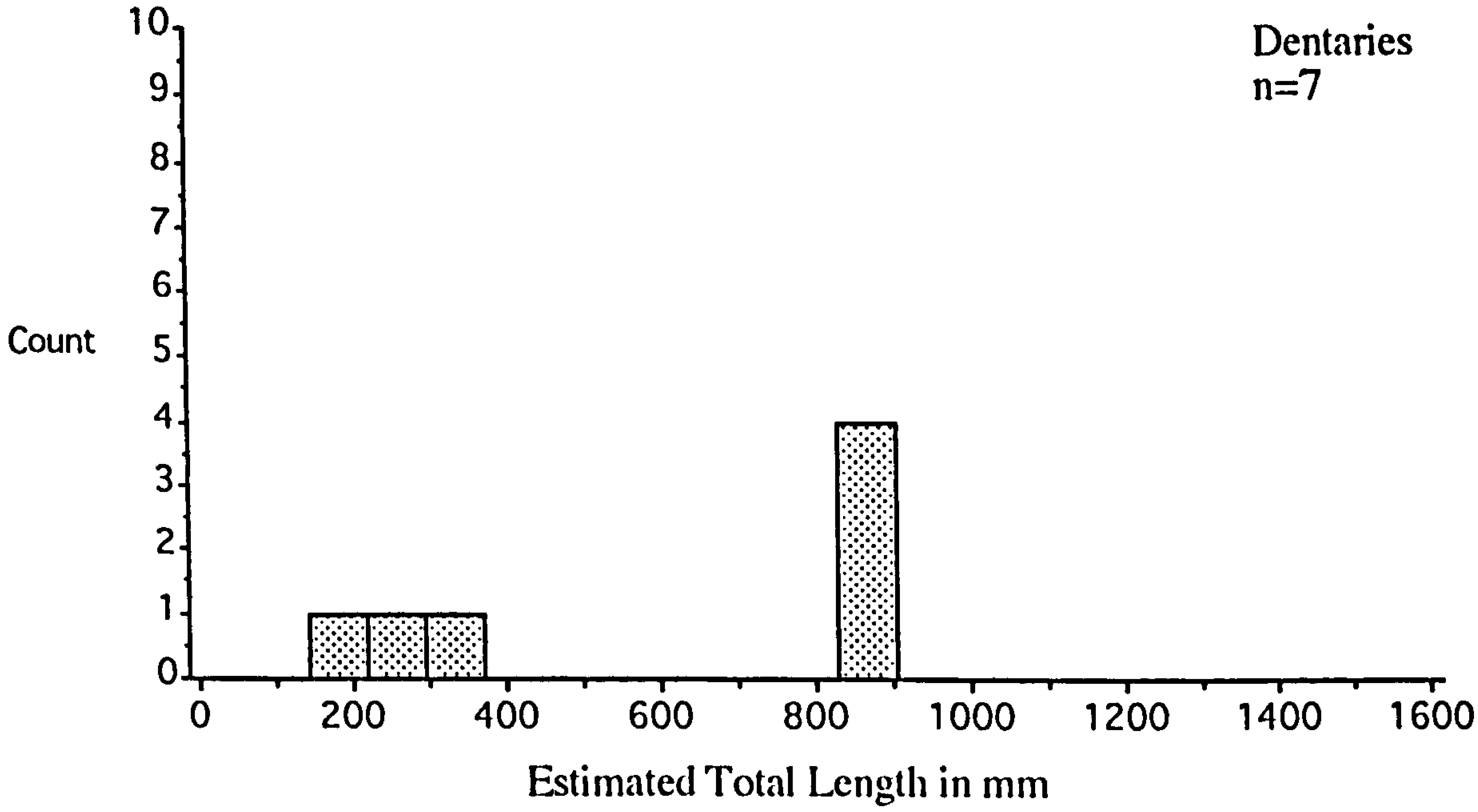


Figure 5.29. Earl's Bu, cod estimated total length distributions based on dentaries and premaxillae.



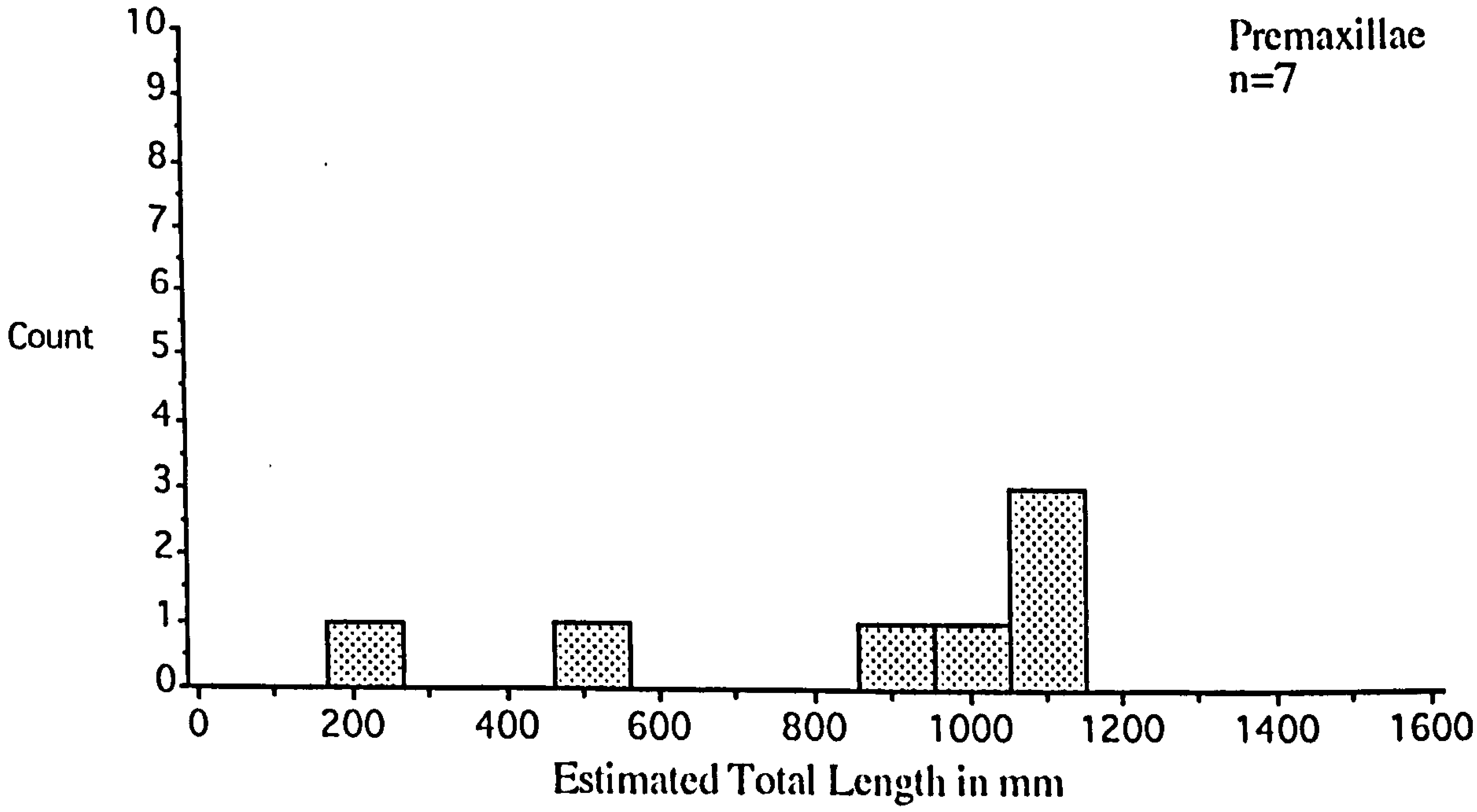


Figure 5.30. Earl's Bu, saith estimated total length distributions based on dentaries and premaxillae.

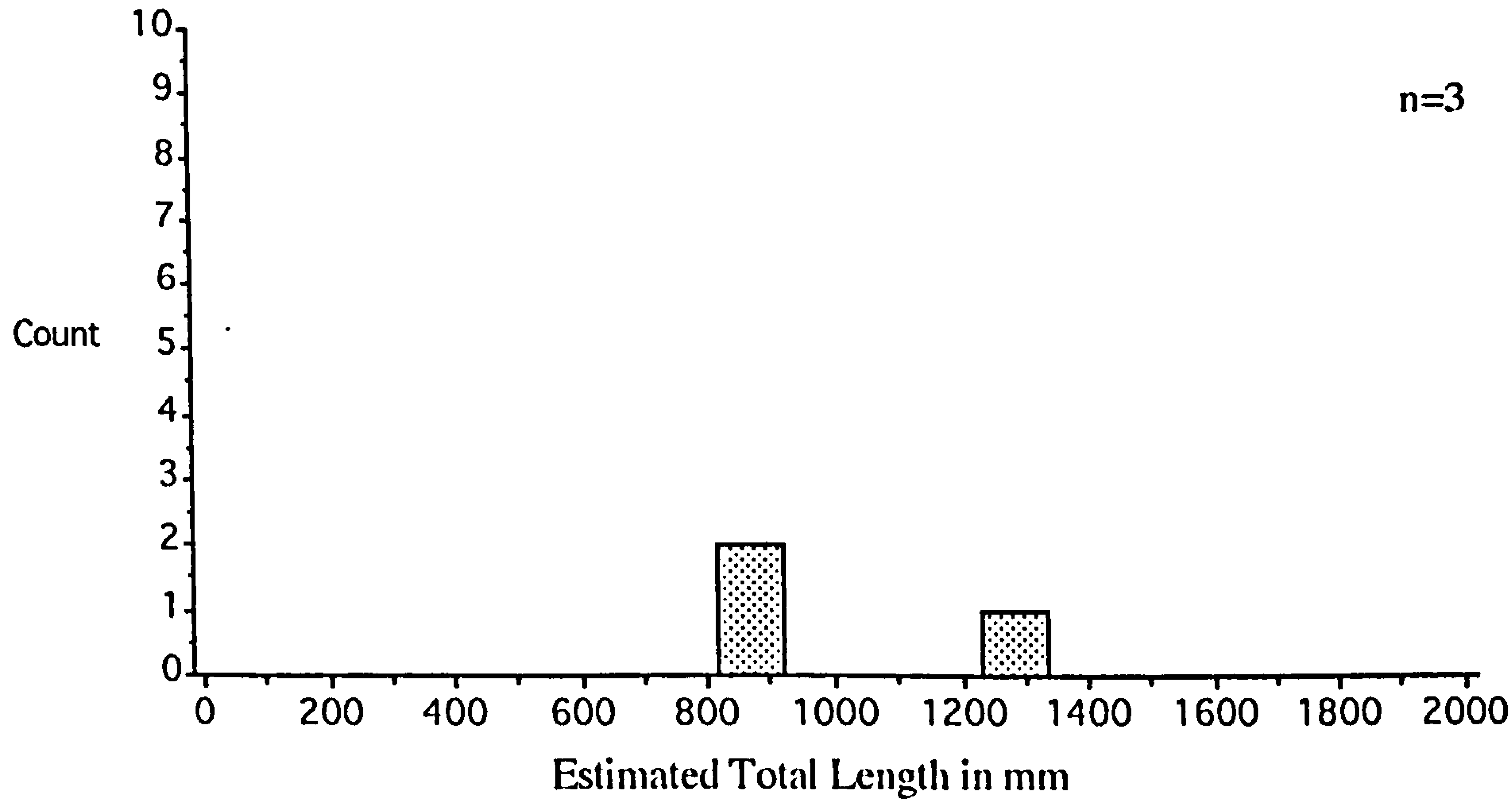
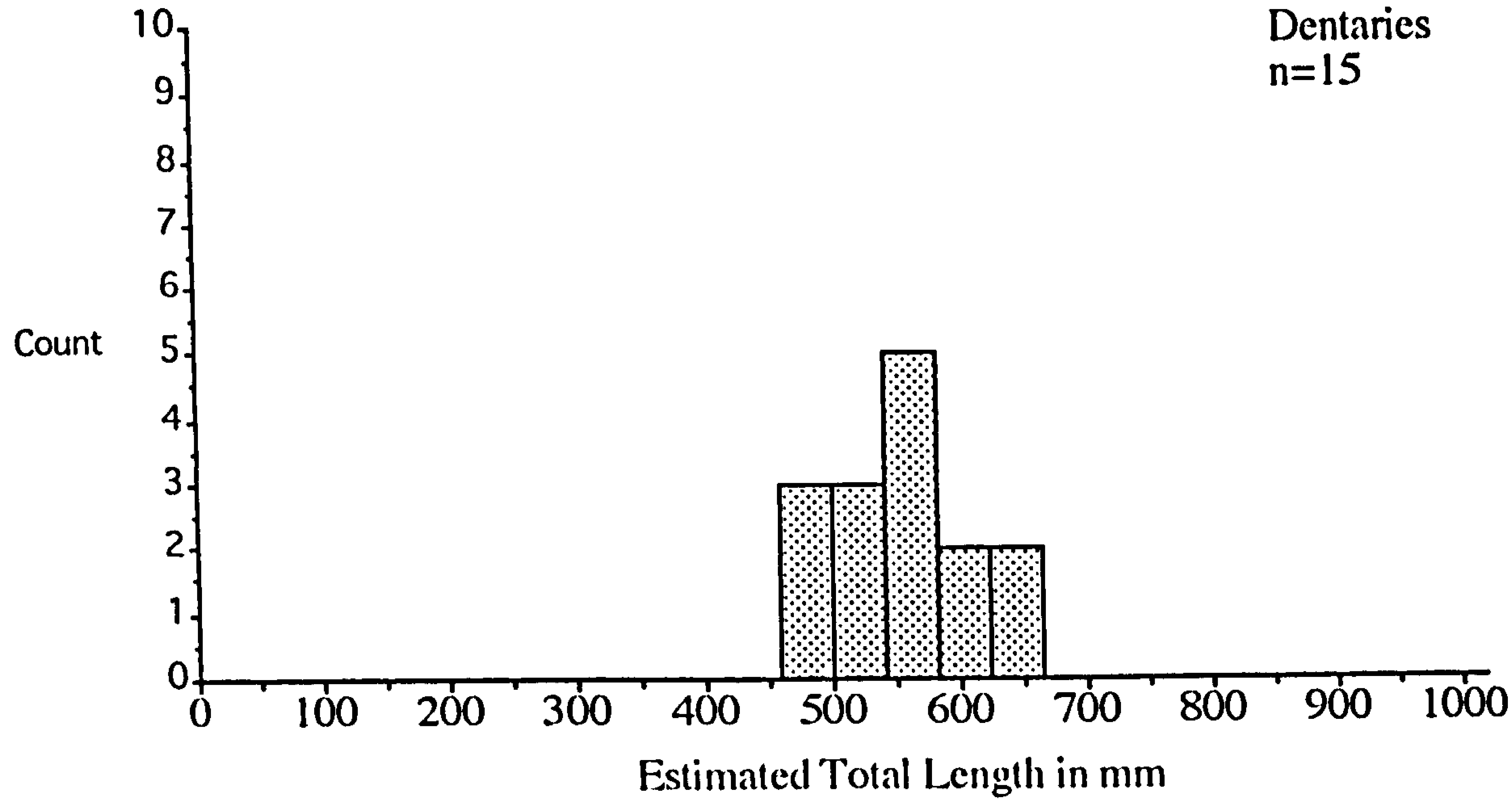


Figure 5.31. Earl's Bu, ling estimated total length distribution based on premaxillae.



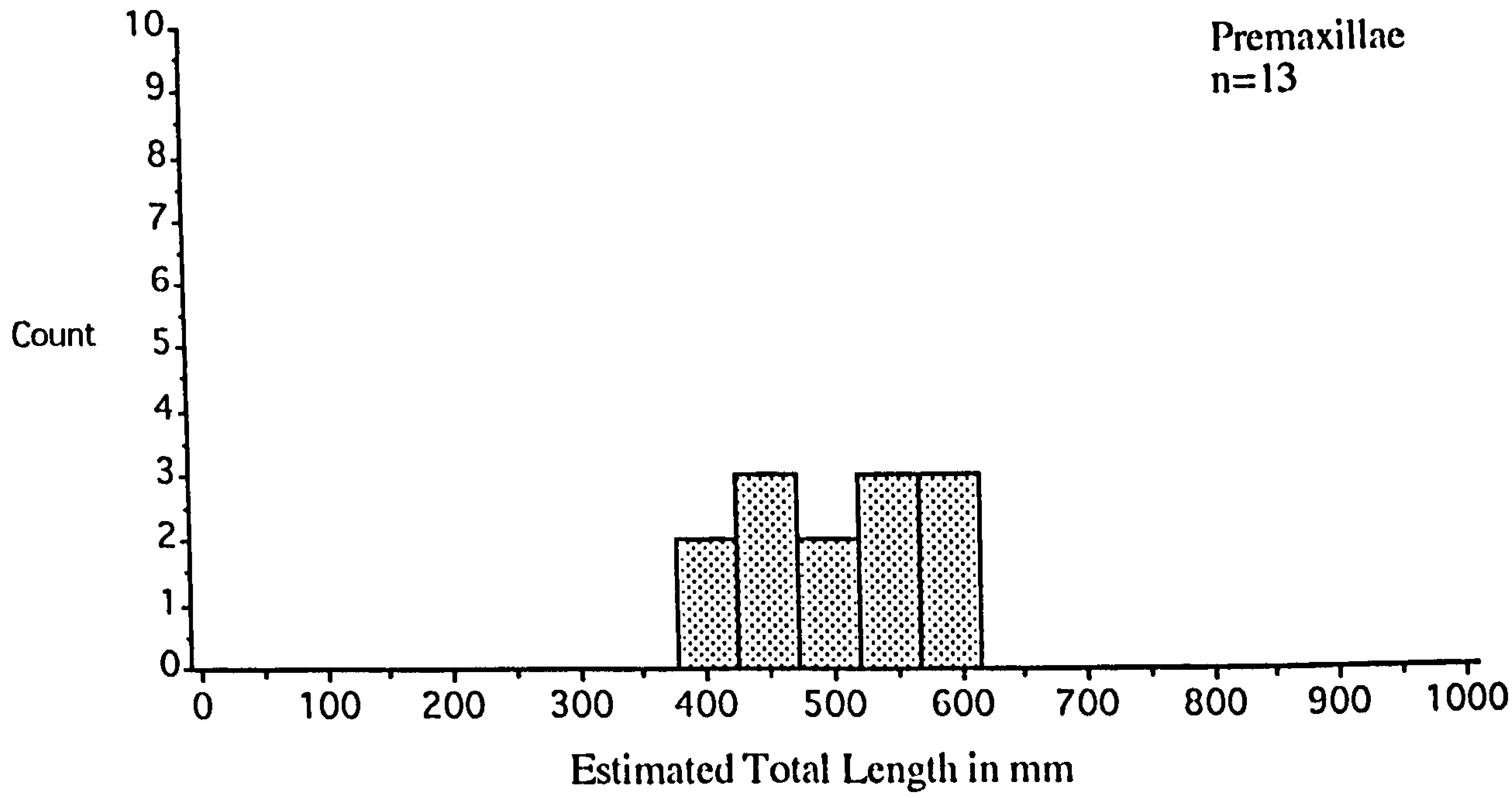


Figure 5.32. Earl's Bu, haddock estimated total length distributions based on dentaries and premaxillae.

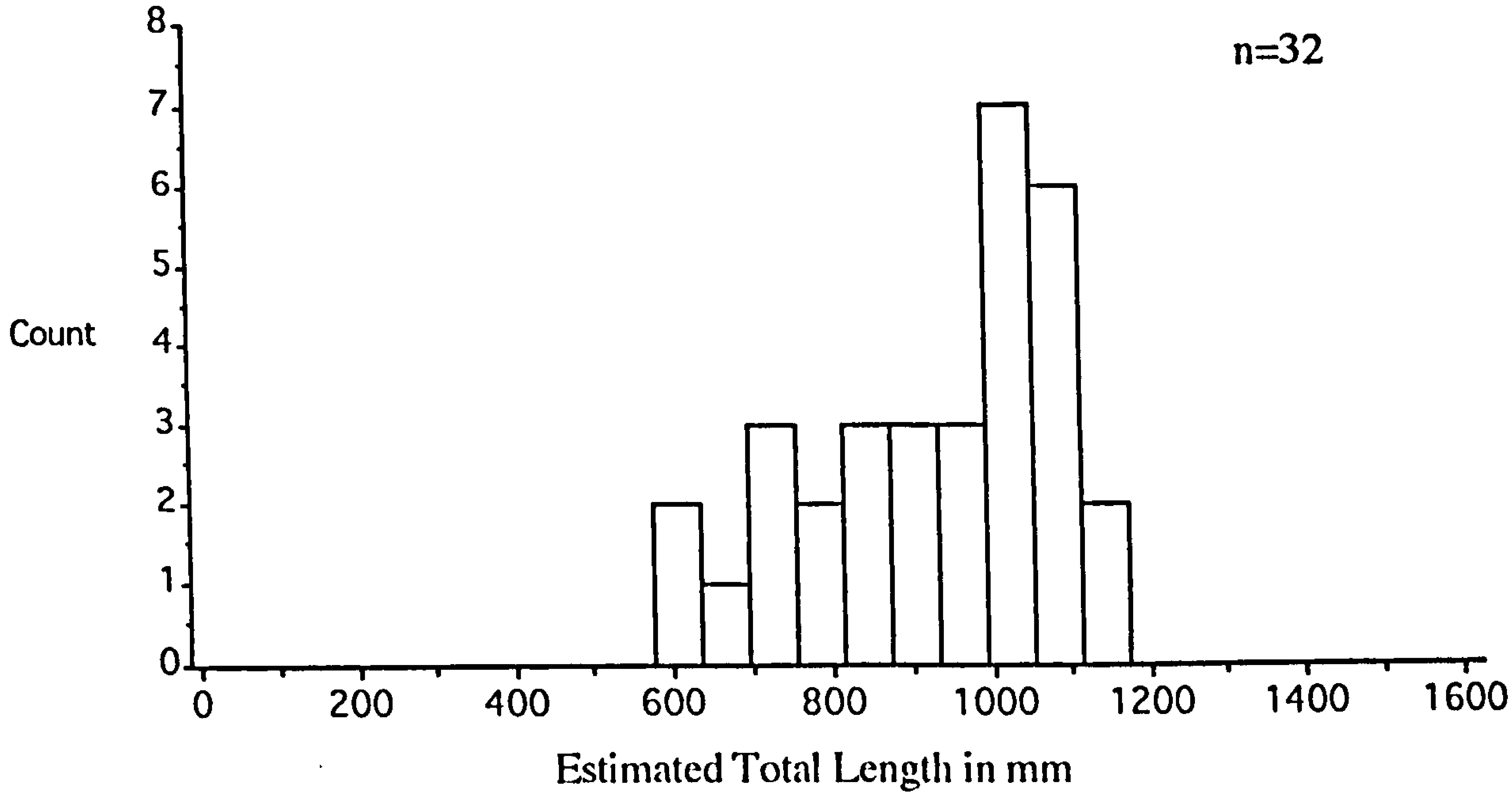


Figure 5.33. Pool Phase 7, cod estimated total length distribution based on premaxillae (data from Nicholson n.d.b; see Appendix 5.5).

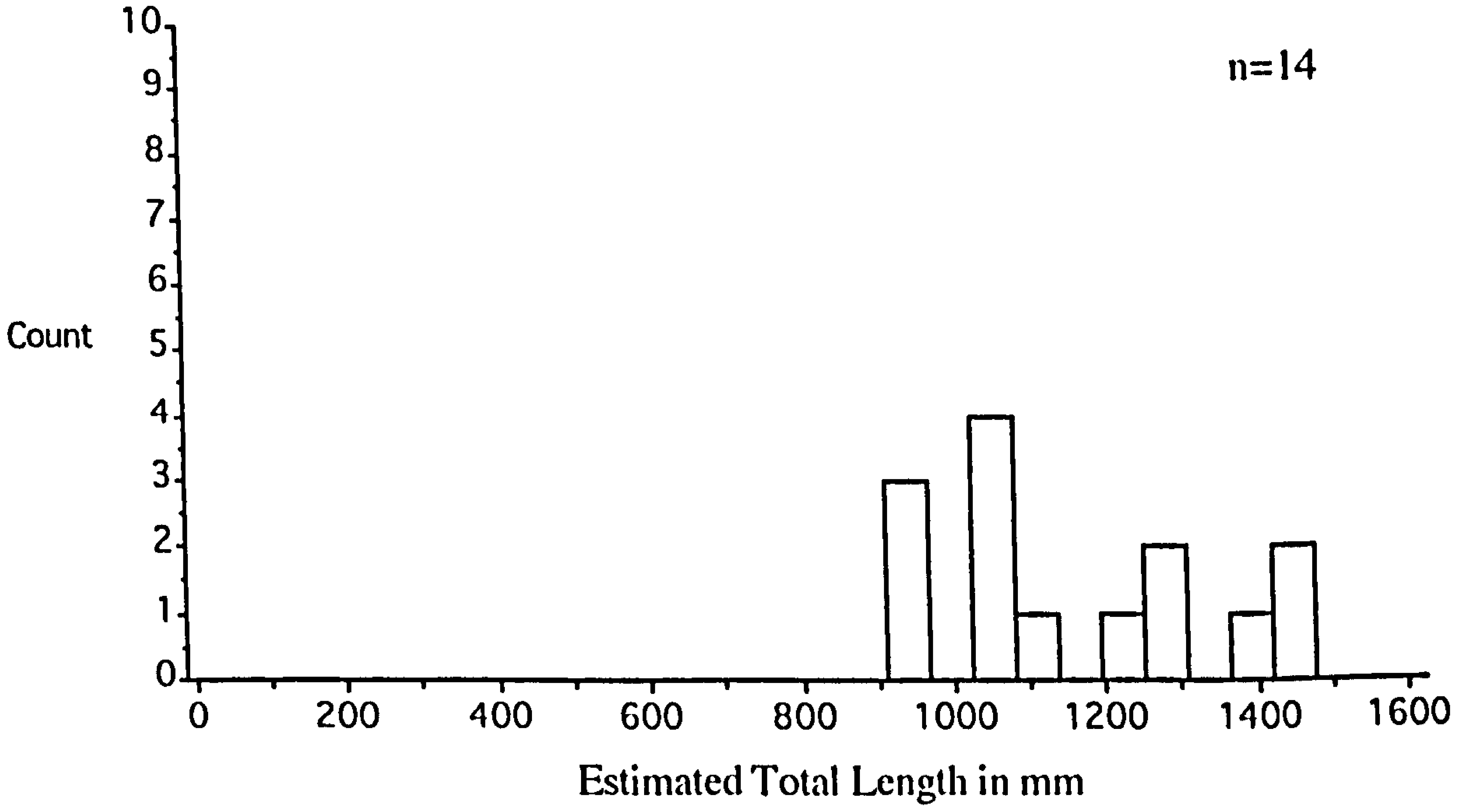


Figure 5.34. Pool Phase 7, saith estimated total length distribution based on premaxillae (data from Nicholson n.d.b; see Appendix 5.5).

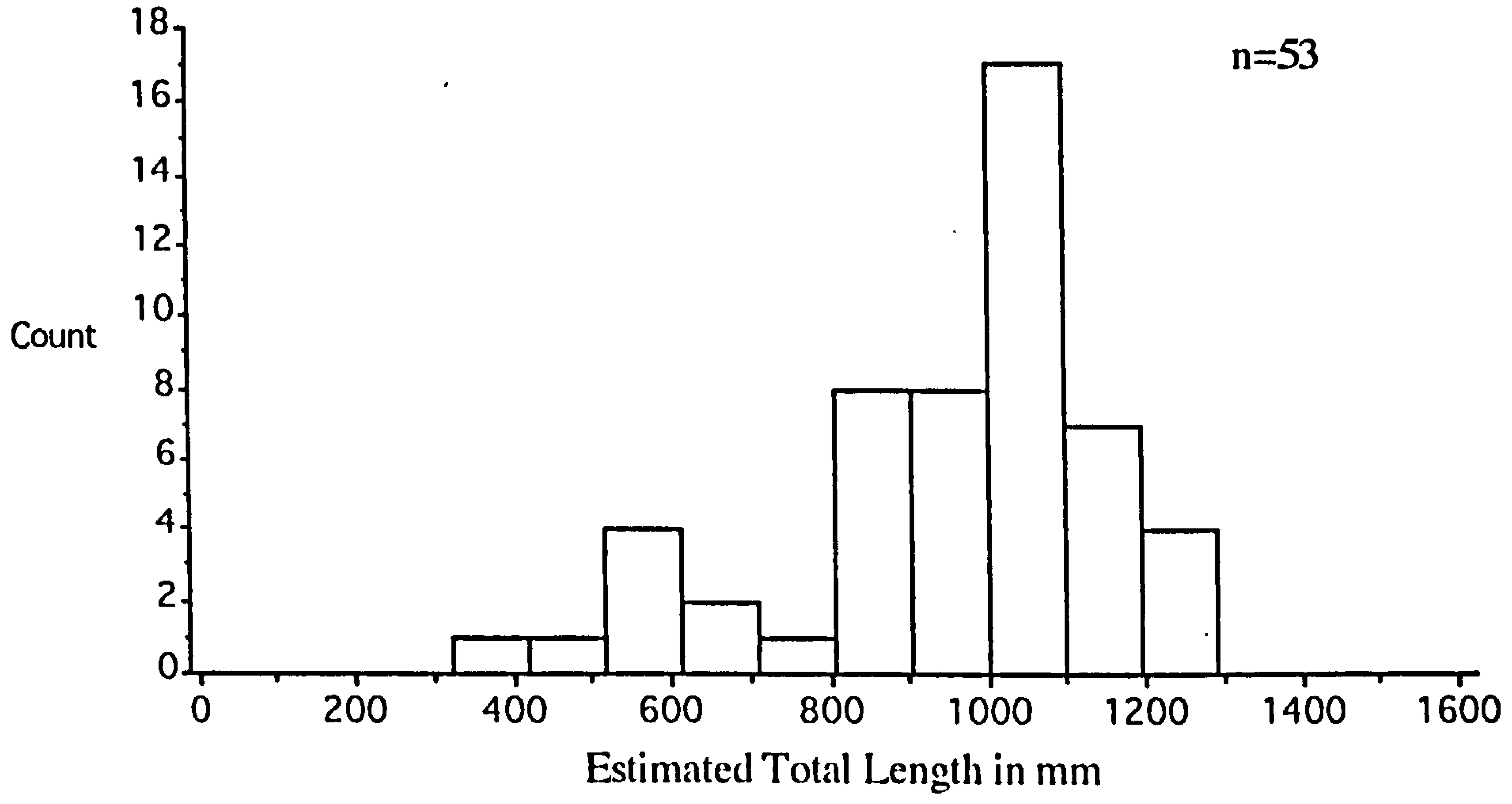


Figure 5.35. Pool Phase 8, cod estimated total length distribution based on premaxillae (data from Nicholson n.d.b; see Appendix 5.5).

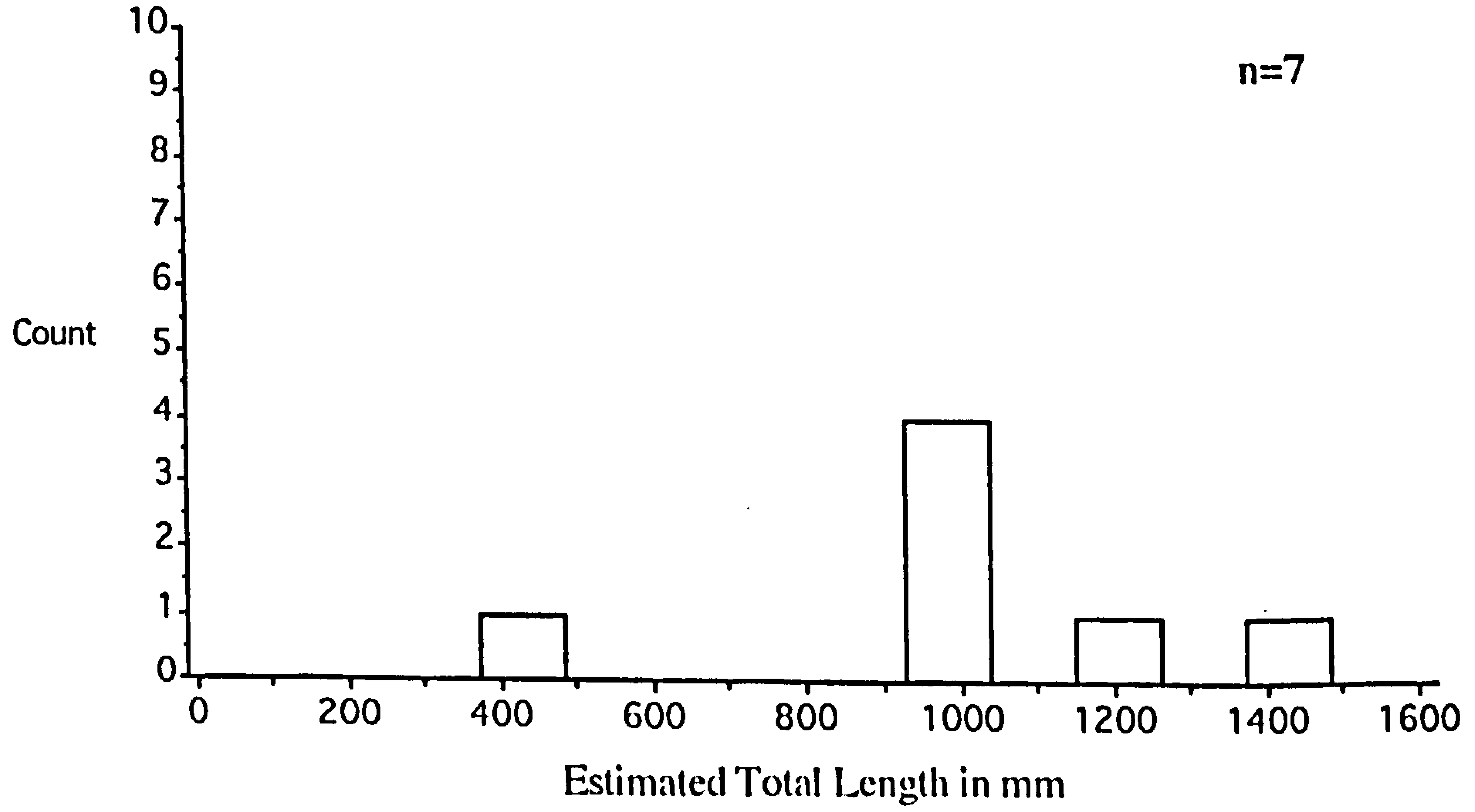


Figure 5.36. Pool Phase 8, saith estimated total length distribution based on premaxillae (data from Nicholson n.d.b; see Appendix 5.5).

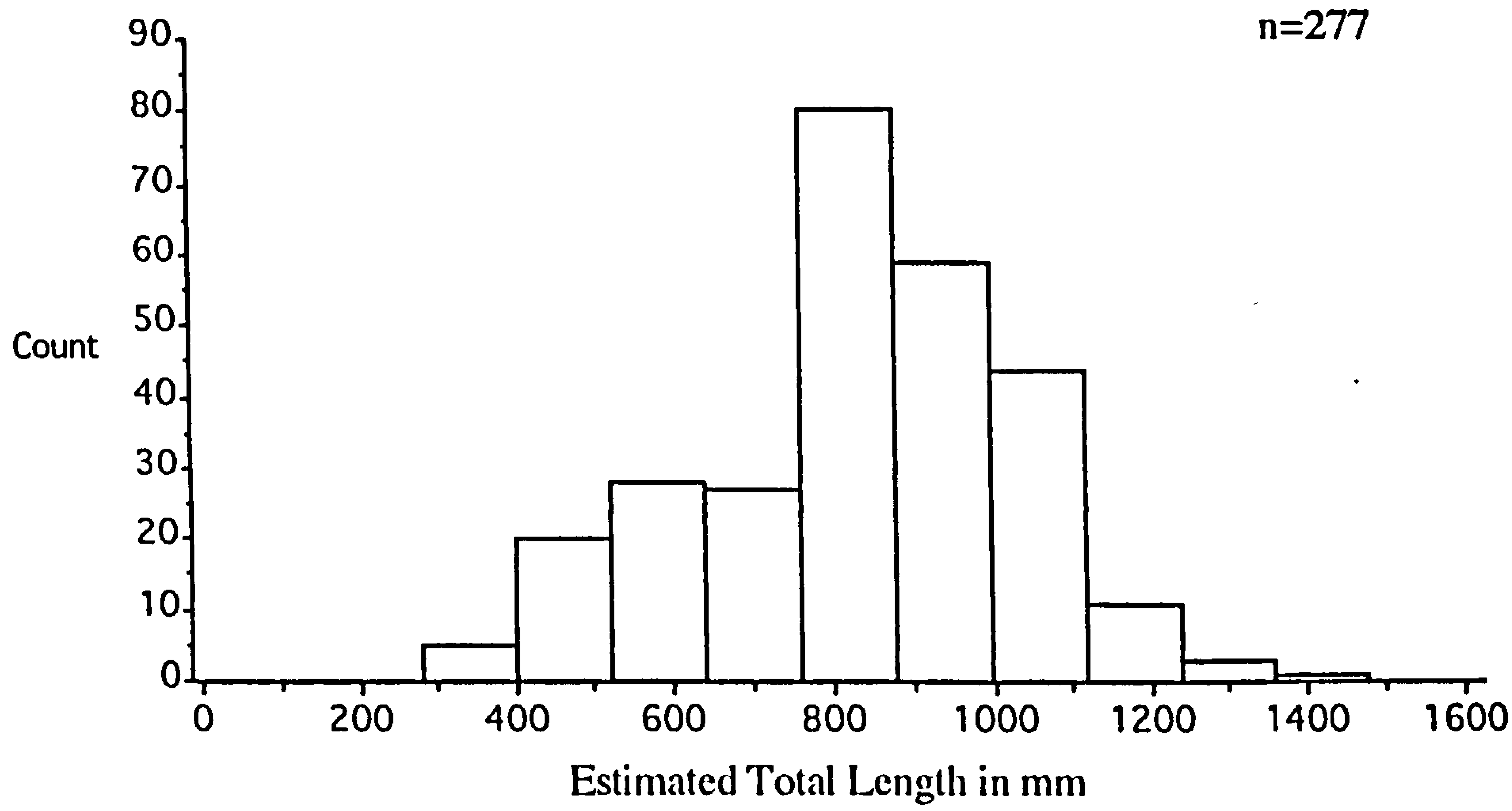


Figure 5.37. Freswick Links, cod estimated total length distribution based on premaxillae (data from Jones 1991a; see Appendix 5.5).

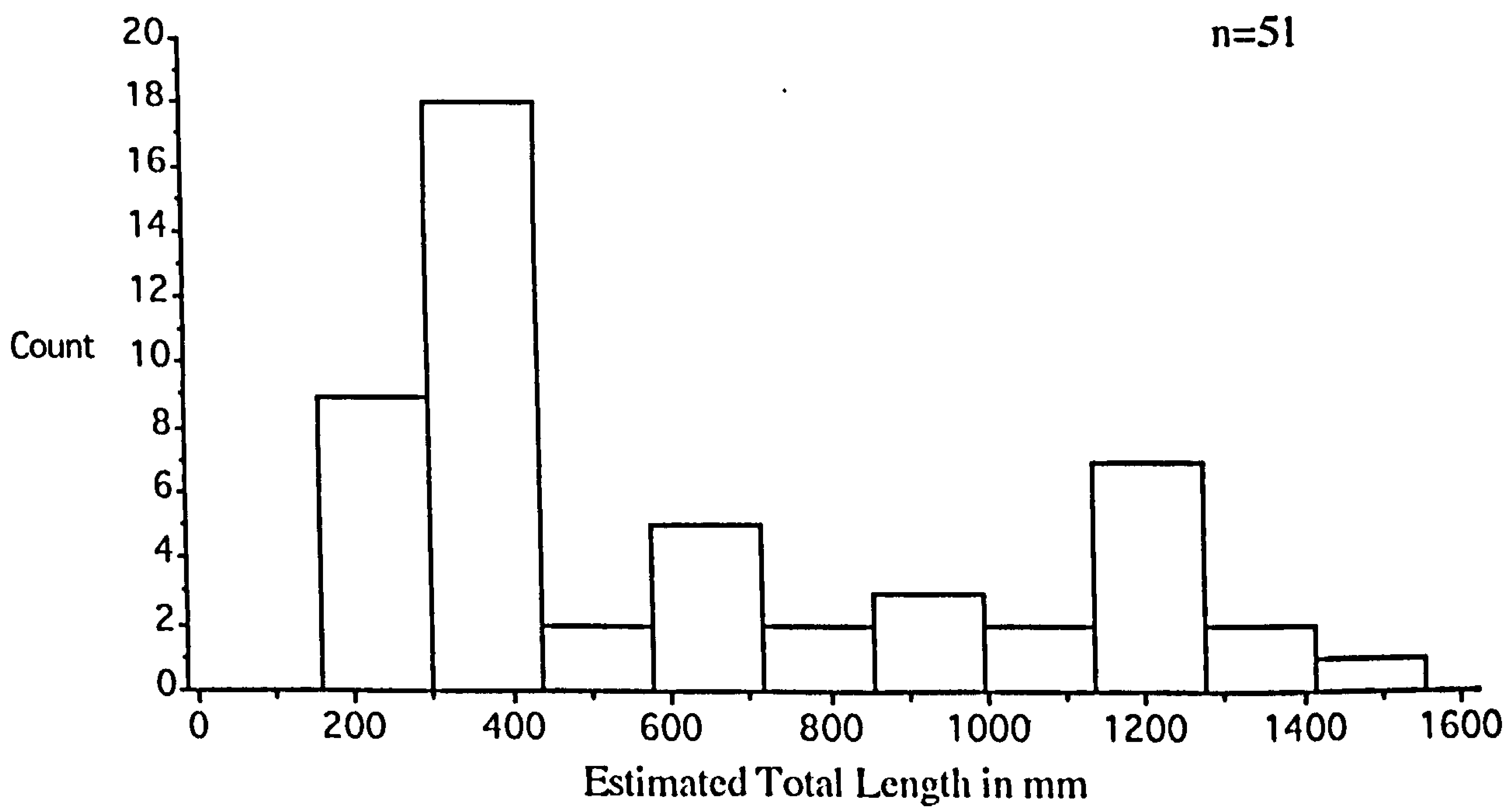


Figure 5.38. Freswick Links, saith estimated total length distribution based on premaxillae (data from Jones 1991a; see Appendix 5.5).

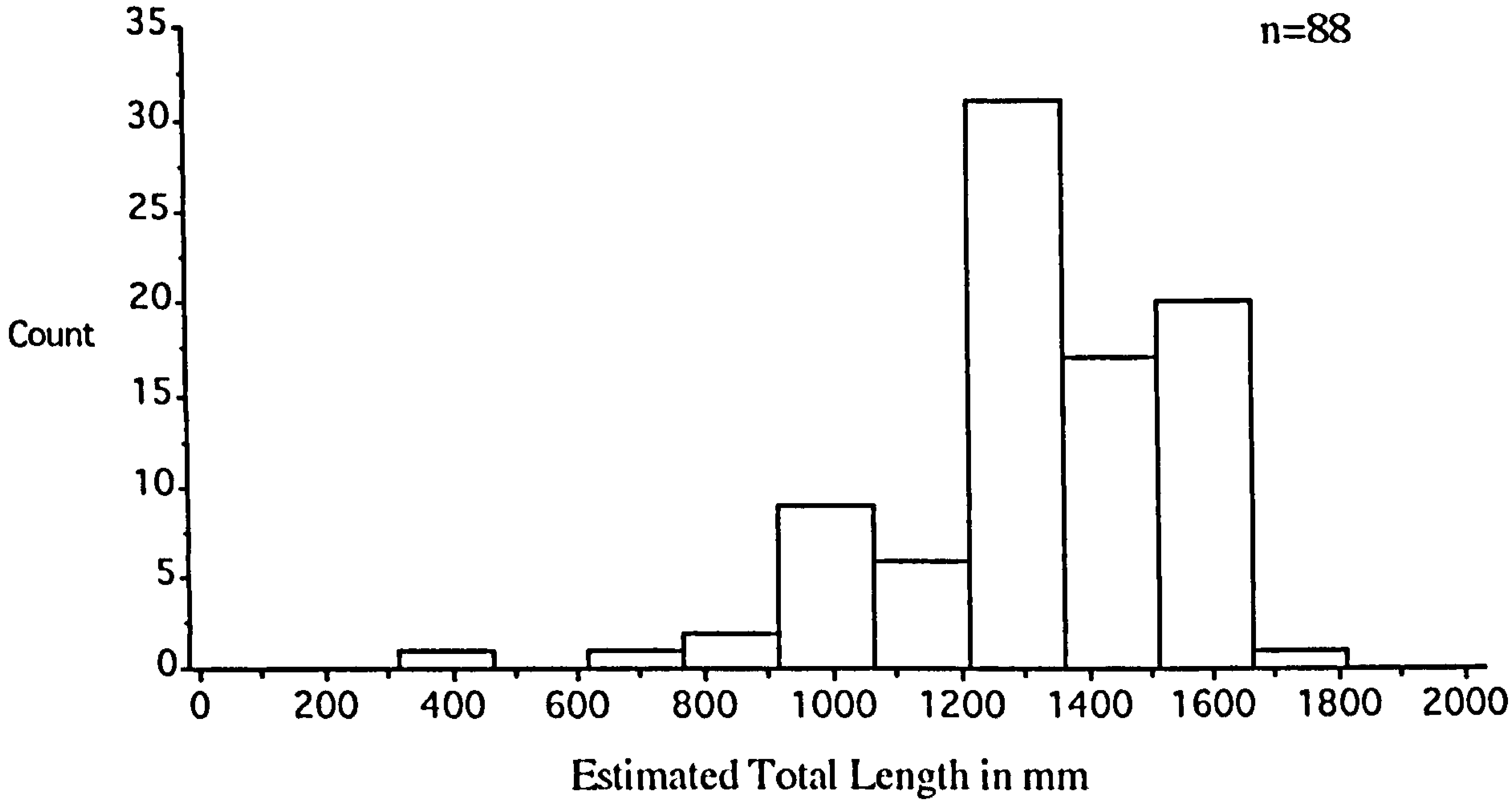


Figure 5.39. Freswick Links, ling estimated total length distribution based on premaxillae (data from Jones 1991a; see Appendix 5.5).

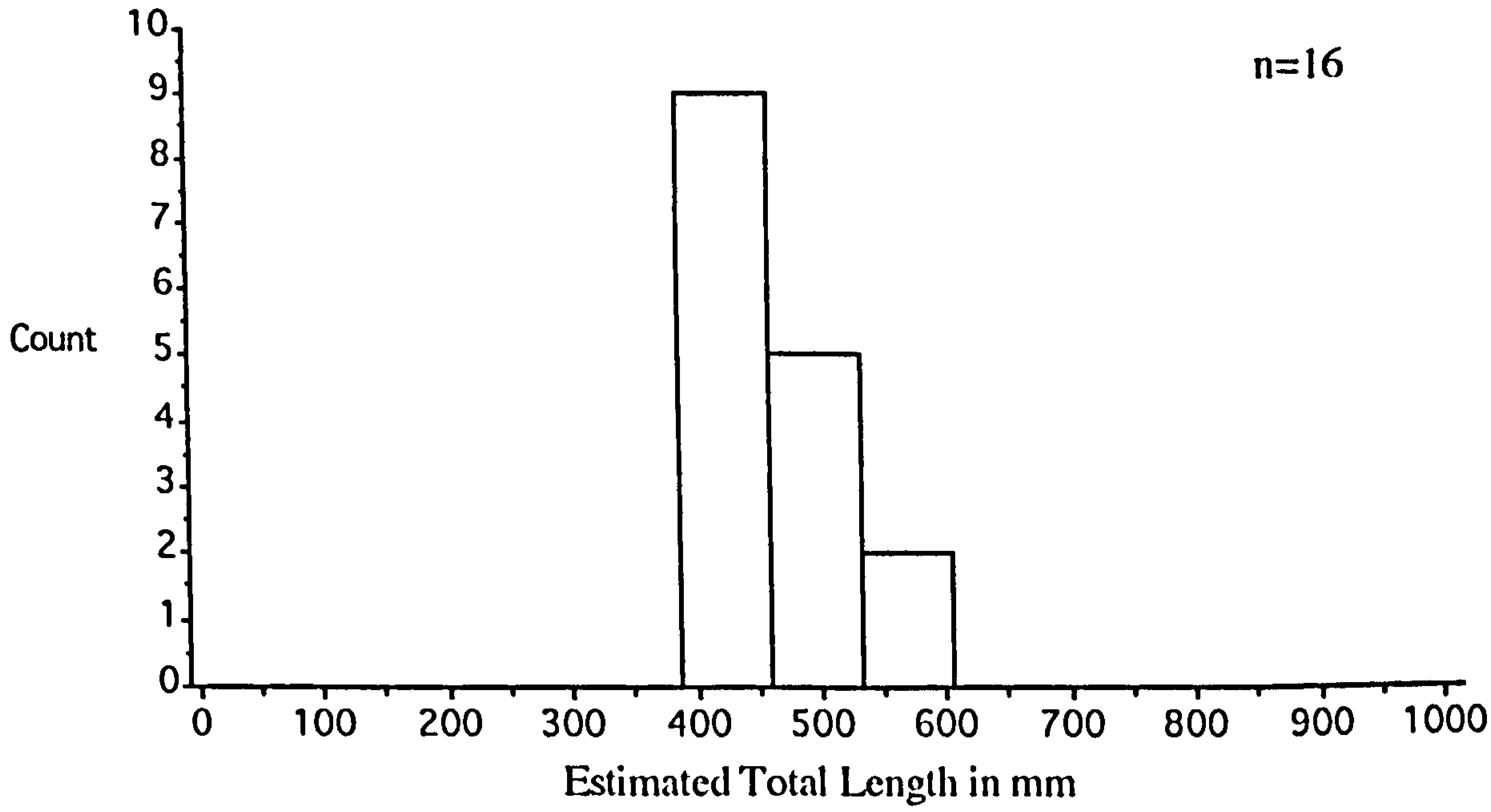


Figure 5.40. Freswick Links, haddock estimated total length distribution based on premaxillae (data from Jones 1991a; see Appendix 5.5).

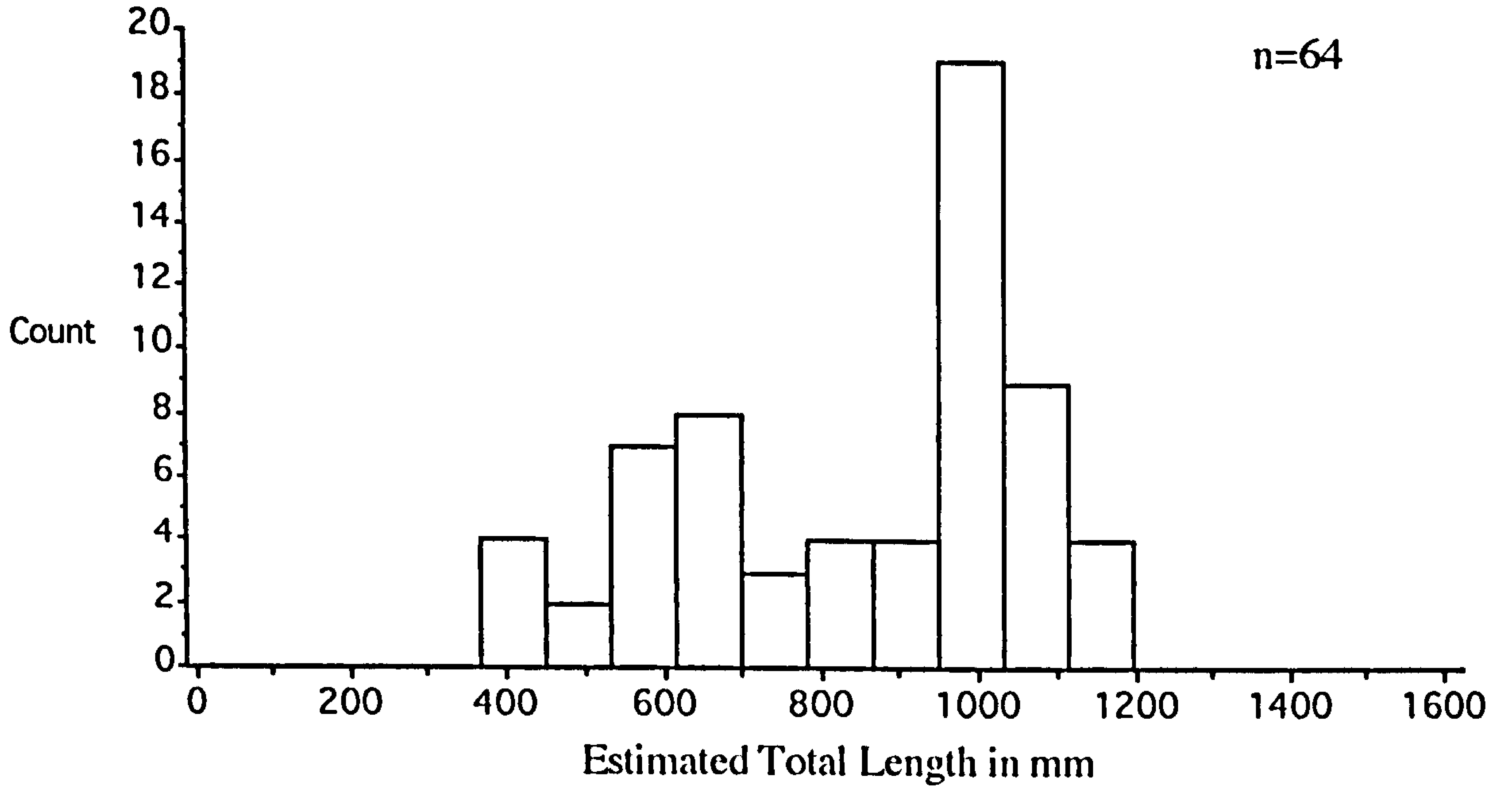


Figure 5.41. Quoygrew, cod estimated total length distribution based on premaxillae (data from Colley 1983a; see Appendix 5.5).

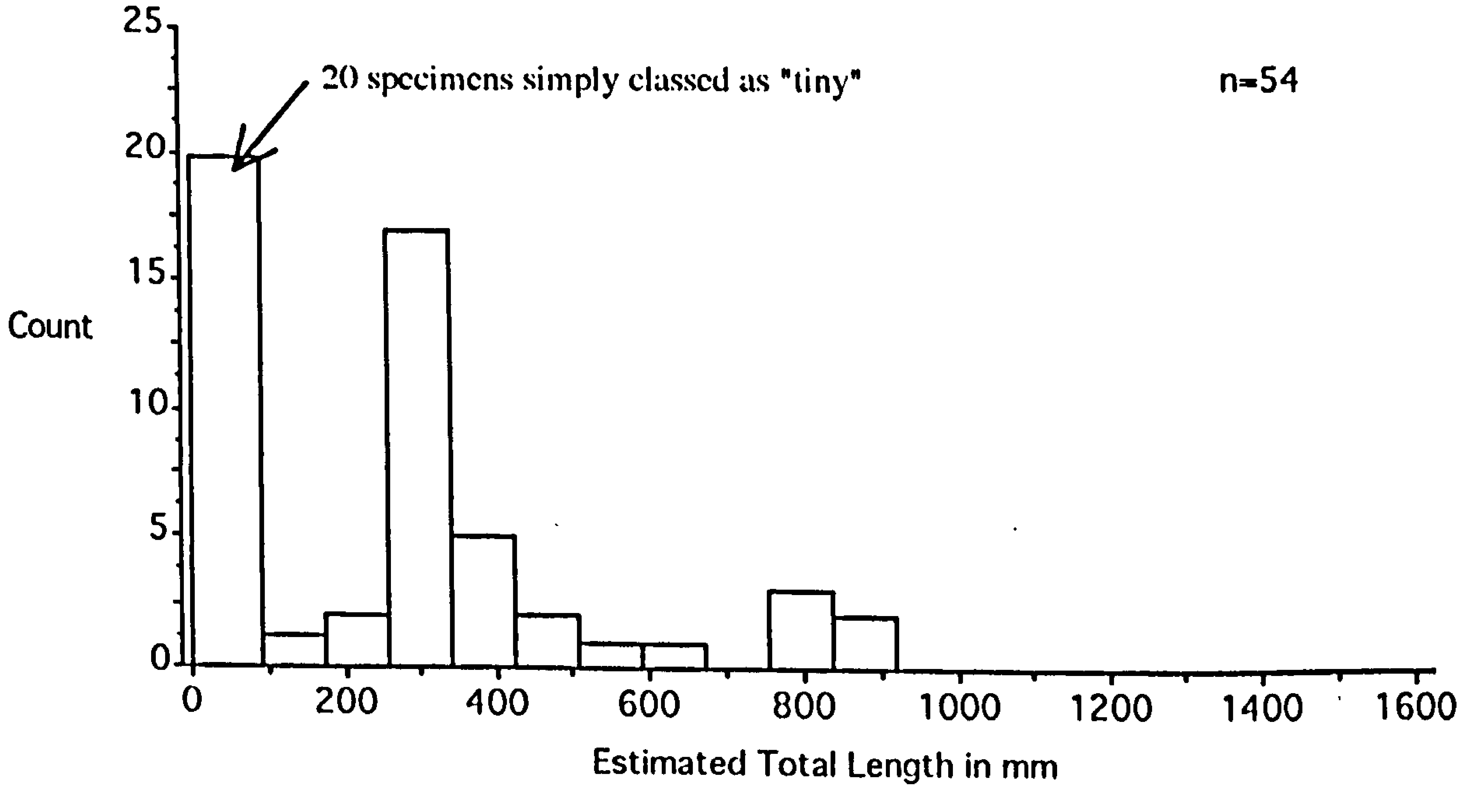


Figure 5.42. Quoygrew, saith estimated total length distribution based on dentaries (data from Colley 1983a; see Appendix 5.5).

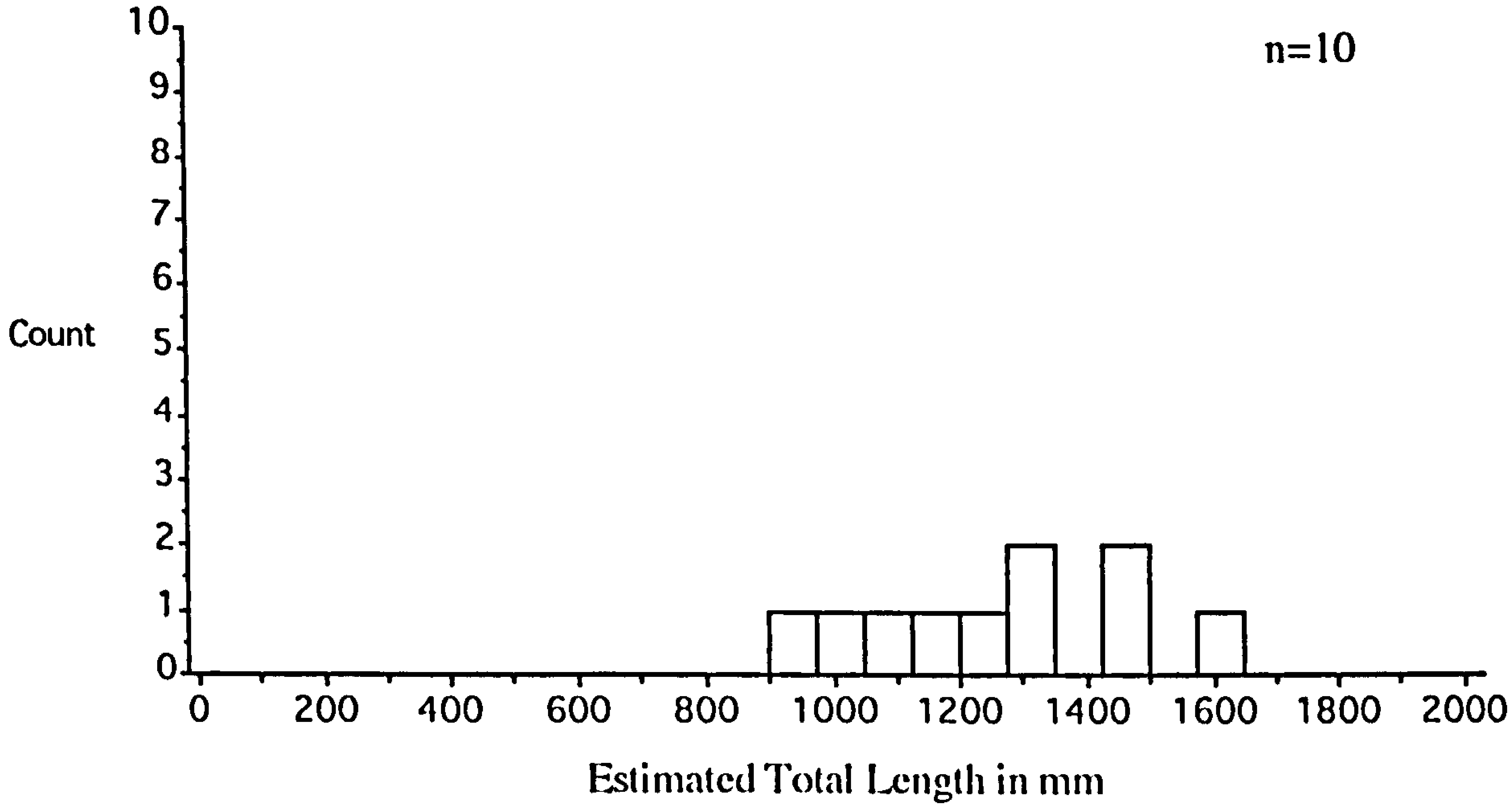


Figure 5.43. Quoygrew, ling estimated total length distribution based on premaxillae (data from Colley 1983a; see Appendix 5.5).

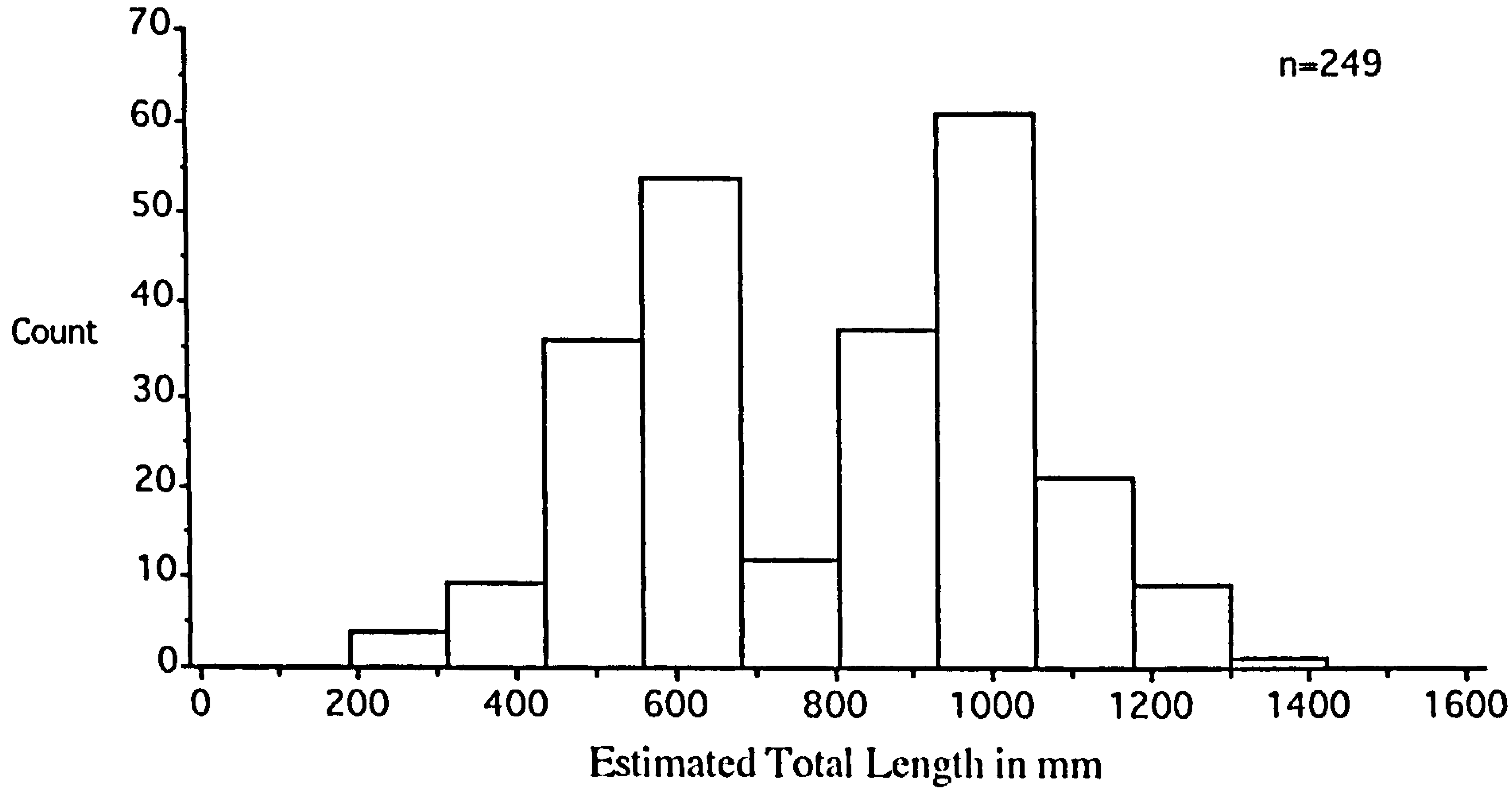


Figure 5.44. Tuquoy, cod estimated total length distribution based on premaxillae (data from Colley 1988; see Appendix 5.5).

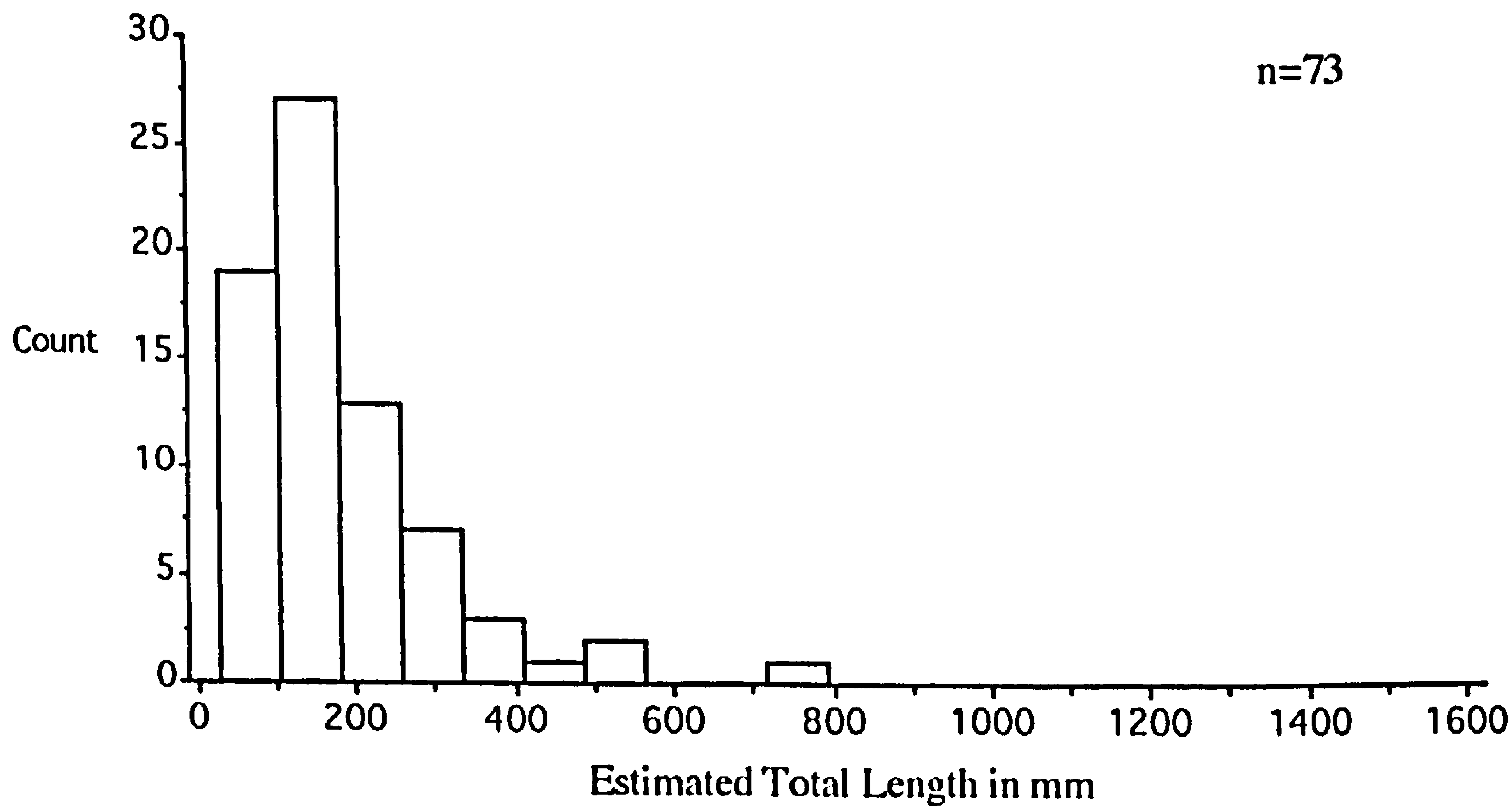


Figure 5.45. Tuquoy, saith estimated total length distribution based on Otoliths (data from Colley 1988; see Appendix 5.5).

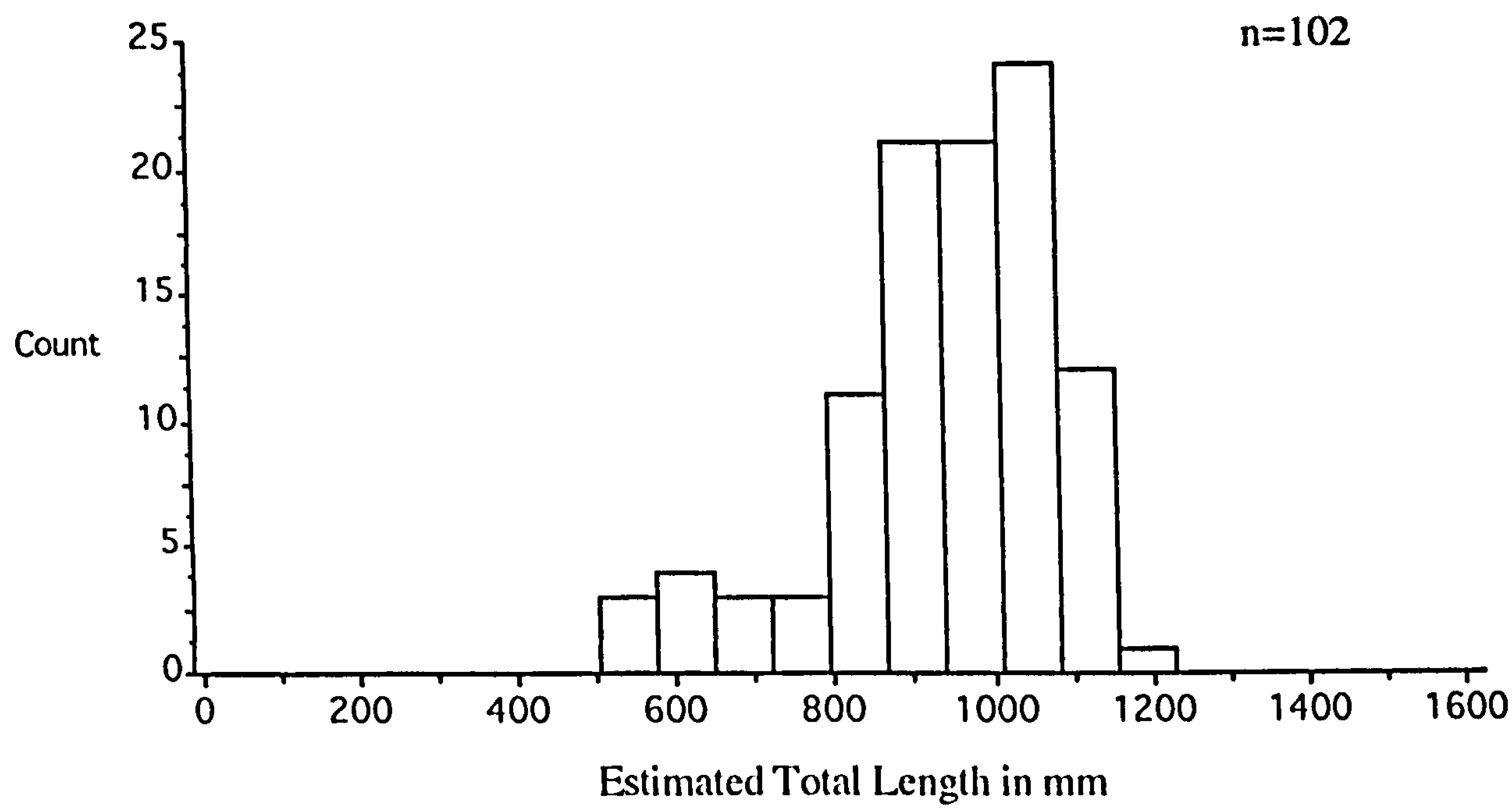


Figure 5.46. Beachview, cod estimated total length distribution based on premaxillae (data from Rackham et al. forthcoming d; see Appendix 5.5).

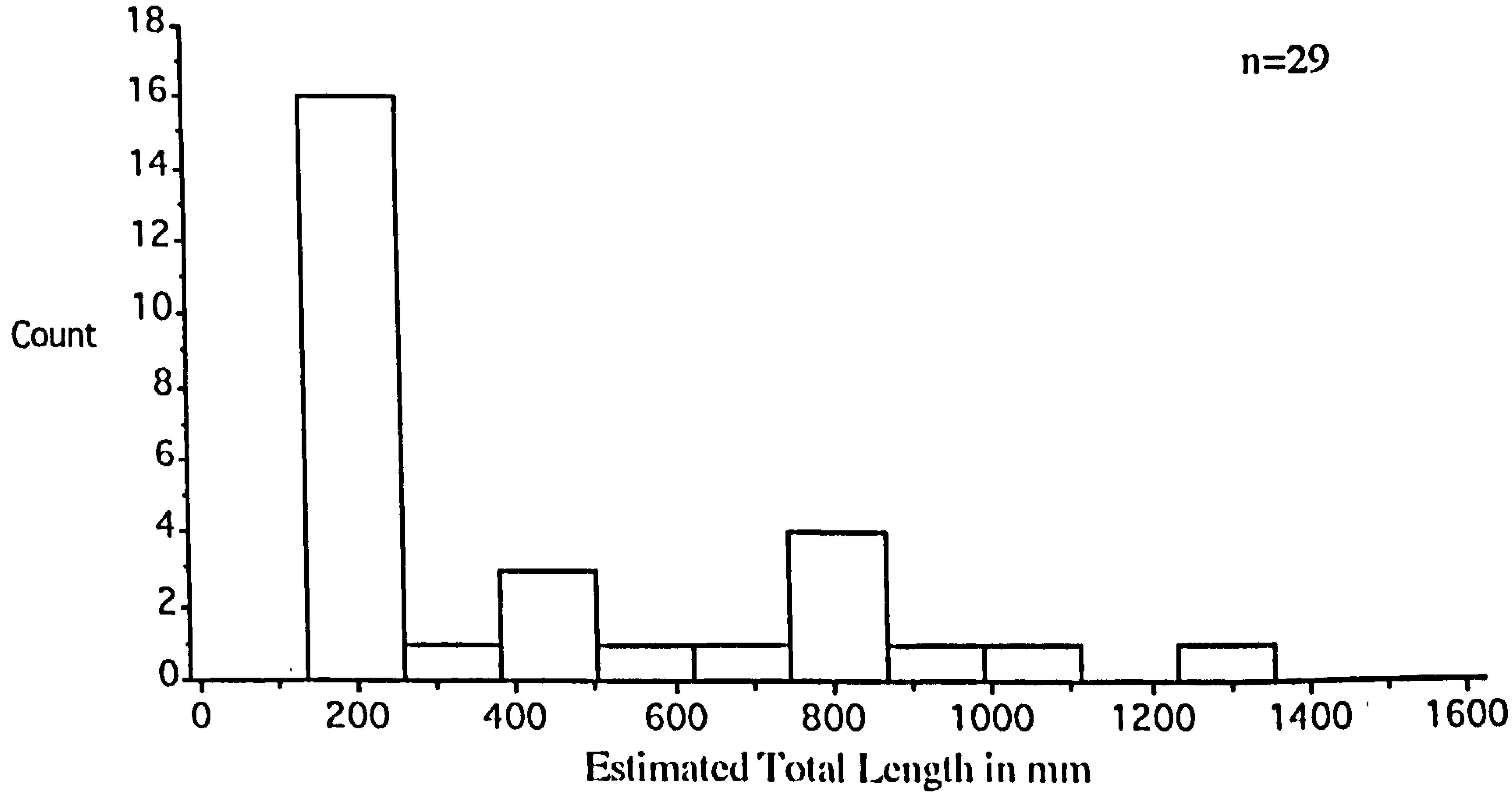


Figure 5.47. Beachview, saith estimated total length distribution based on premaxillae (data from Rackham et al. forthcoming d; see Appendix 5.5).

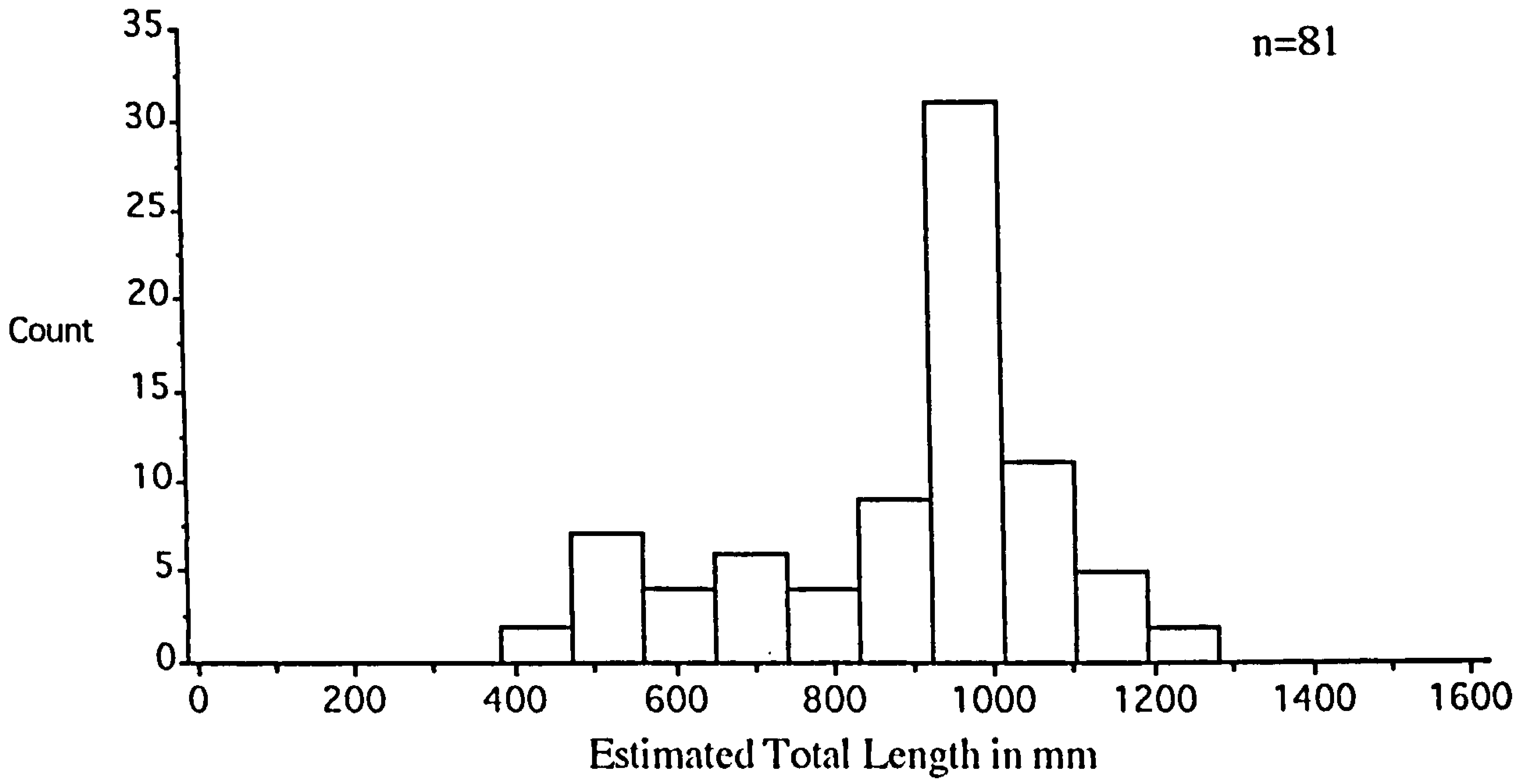


Figure 5.48. Sandwick, cod estimated total length distribution based on premaxillae (data from Bigelow 1984; see Appendix 5.5).

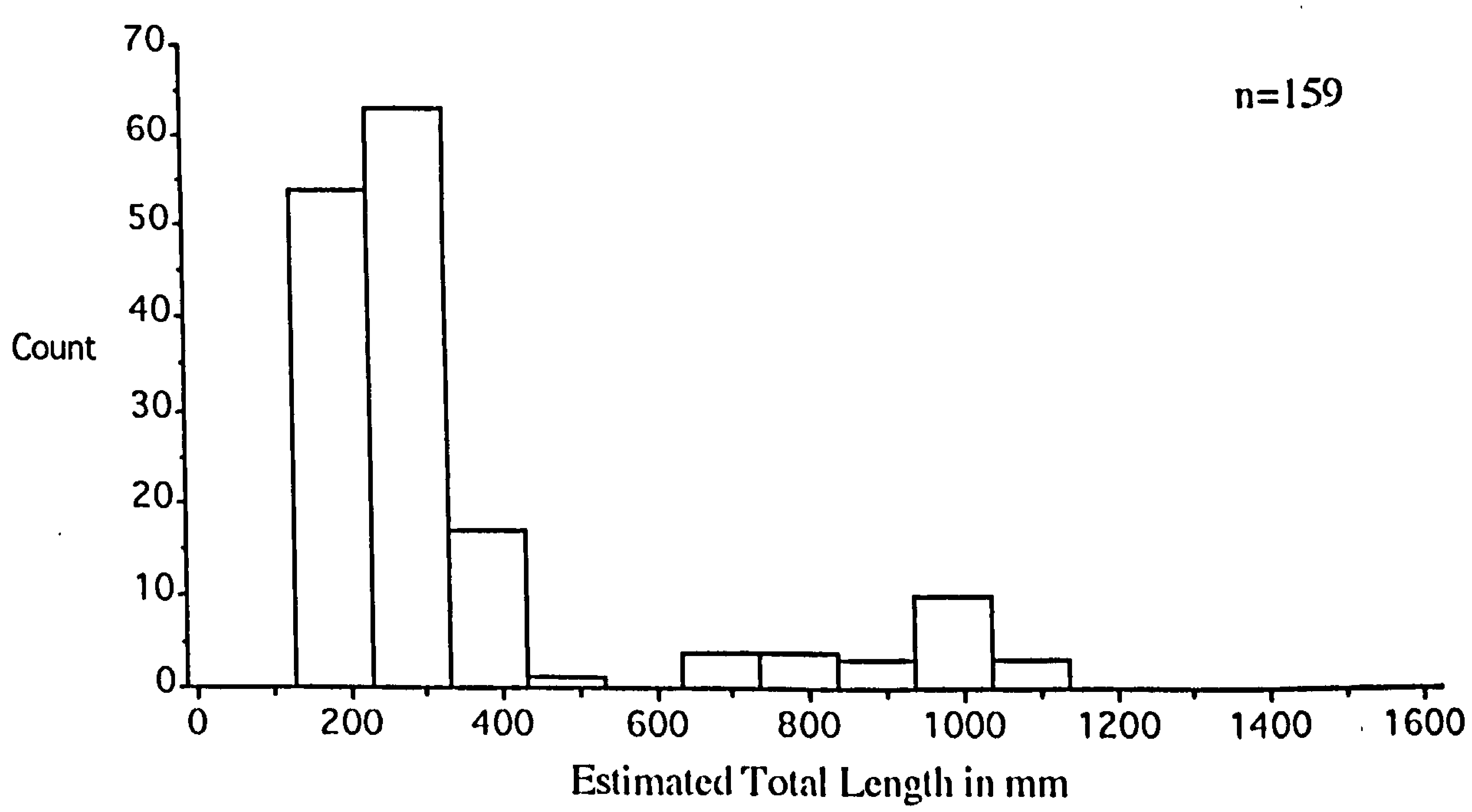


Figure 5.49. Sandwick, saith estimated total length distribution based on otoliths (data from Bigelow 1984; see Appendix 5.5).

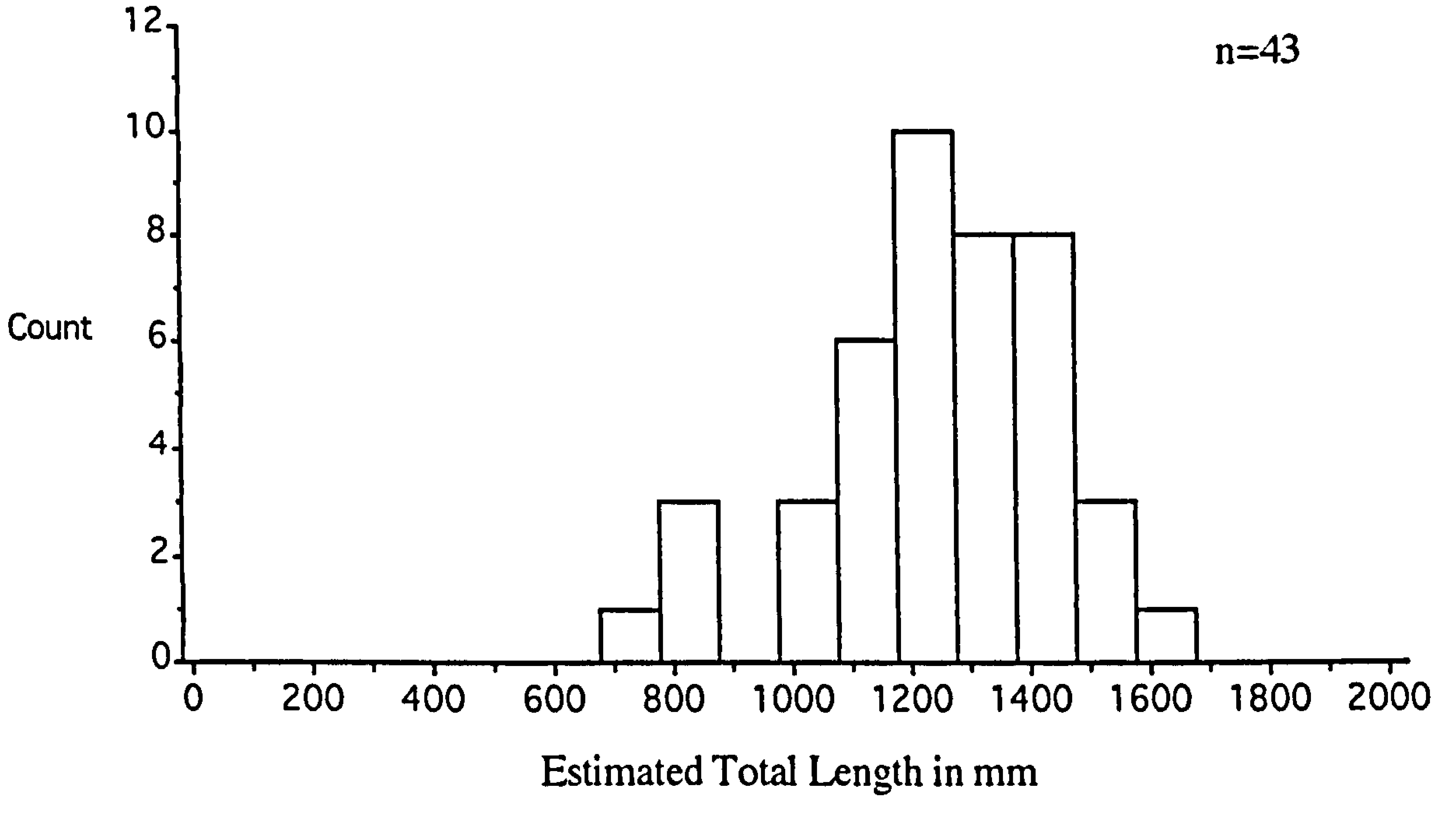


Figure 5.50. Sandwick, ling estimated total length distribution based on premaxillae (data from Bigelow 1984; see Appendix 5.5).

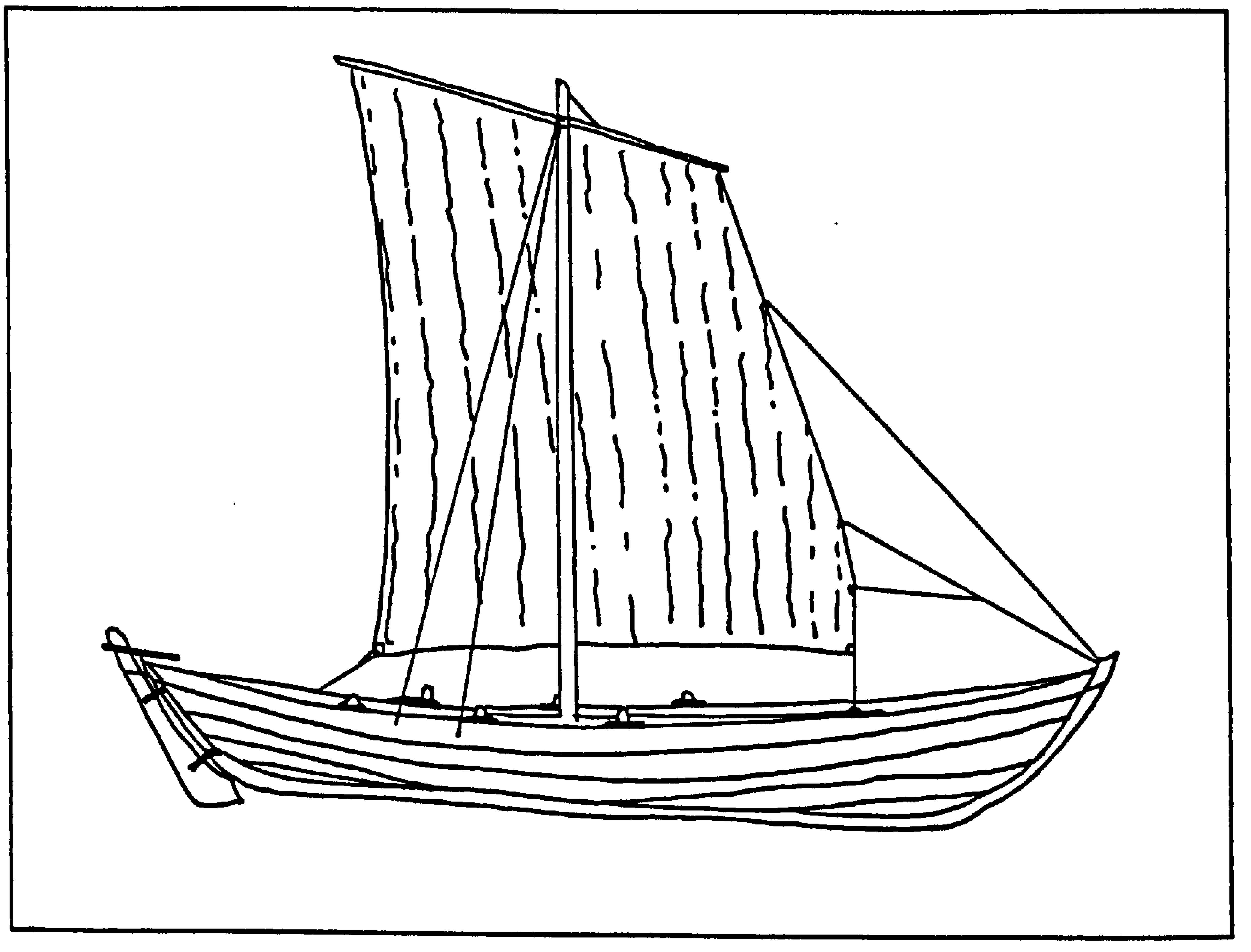


Figure 5.51. A traditional Shetlandic fishing boat: The Ness Yole (from Morrison 1978:73). These inshore fishing boats were consistently 22.5 feet (6.86m) in total length (Henderson 1978:53).

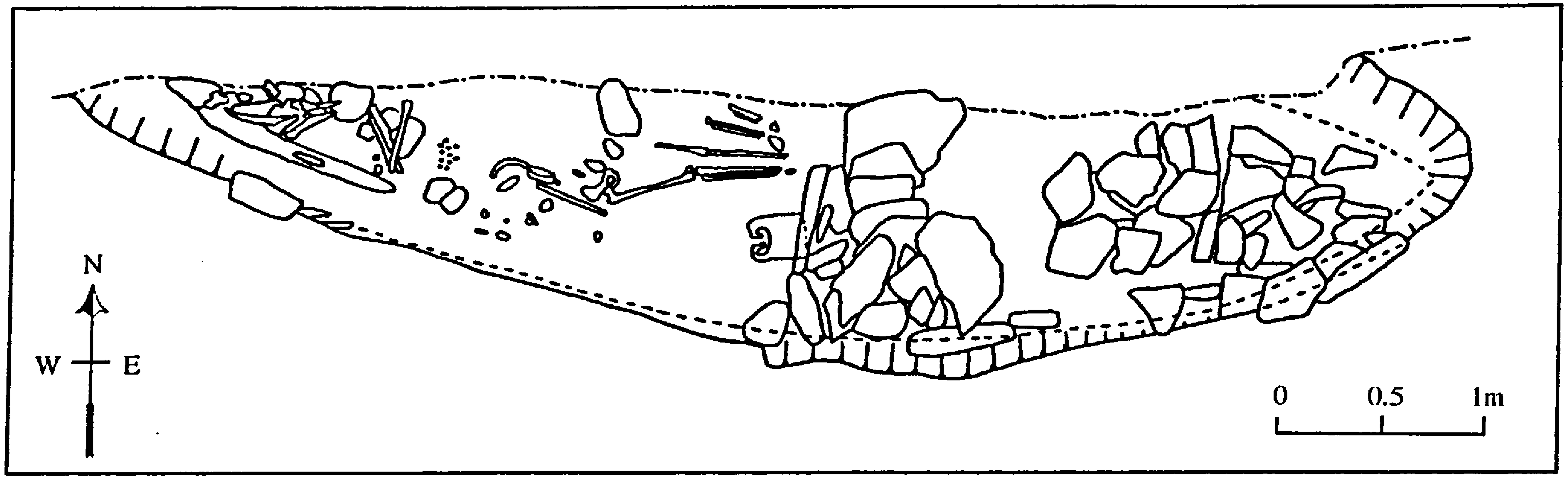
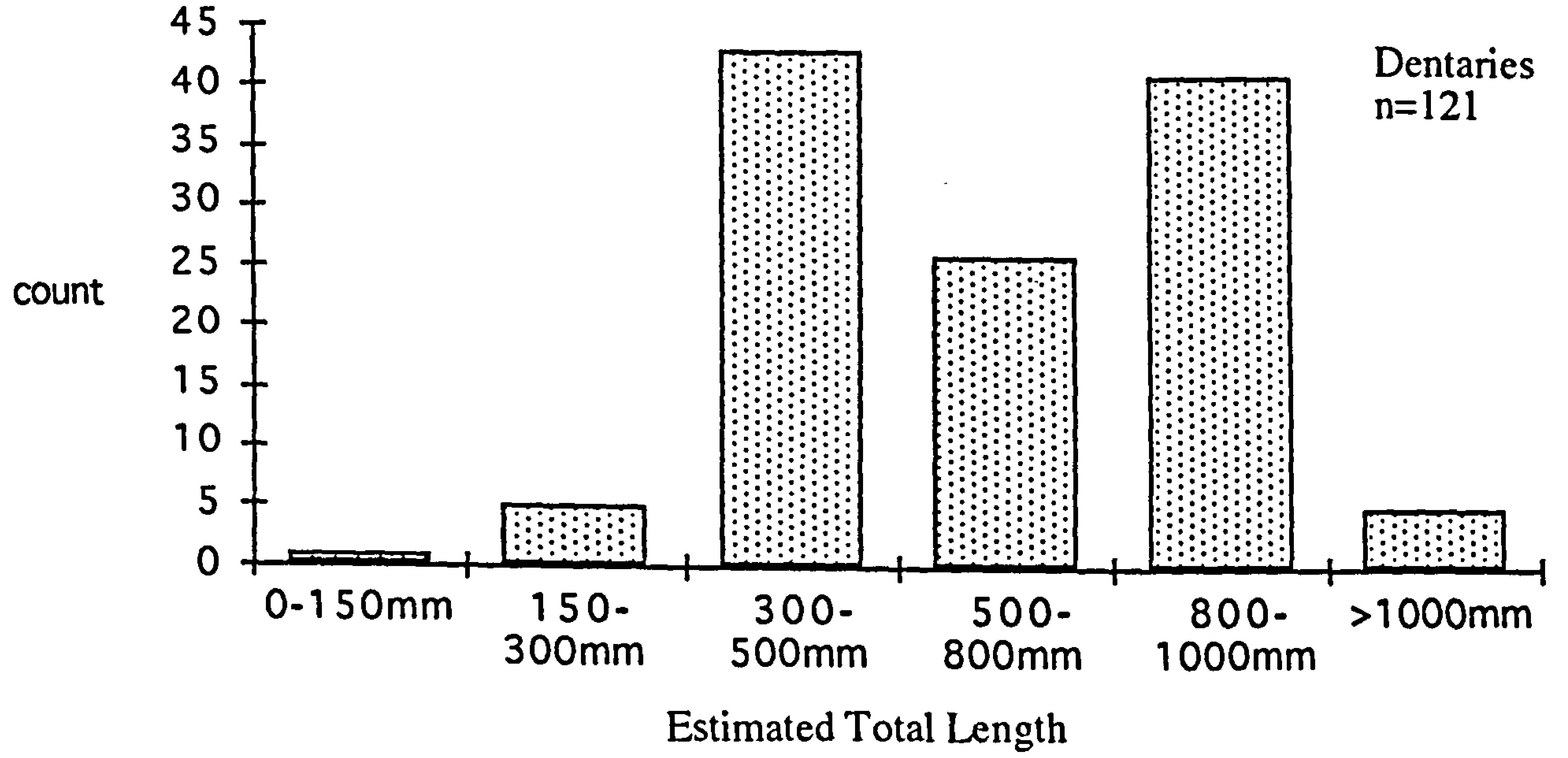


Figure 5.52. The Viking Age boat burial at Scar, Sanday, Orkney (after Dalland 1992:475).



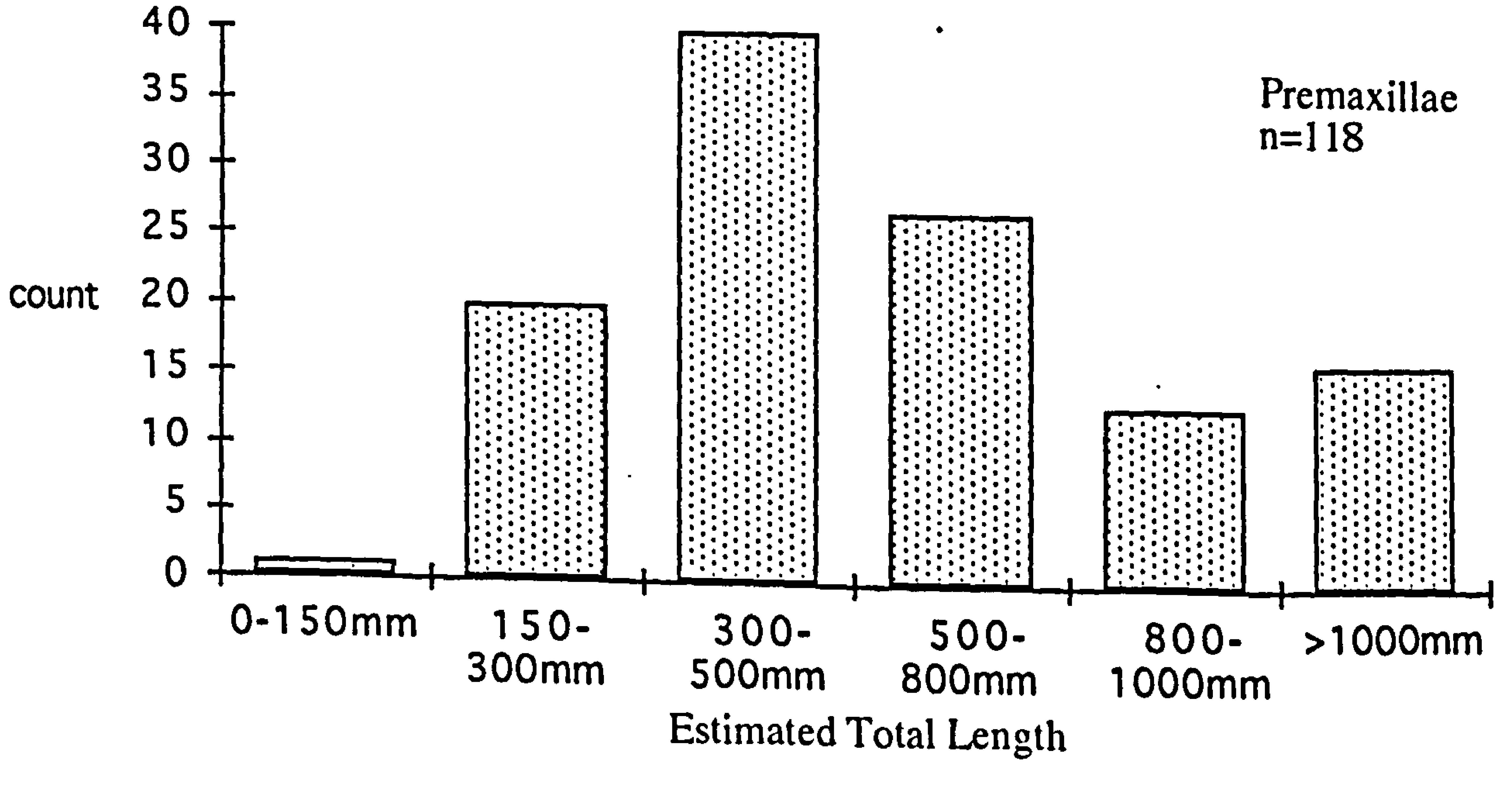


Figure 5.53. Robert's Haven, saith qualitative total length estimates from dentaries and premaxillae.

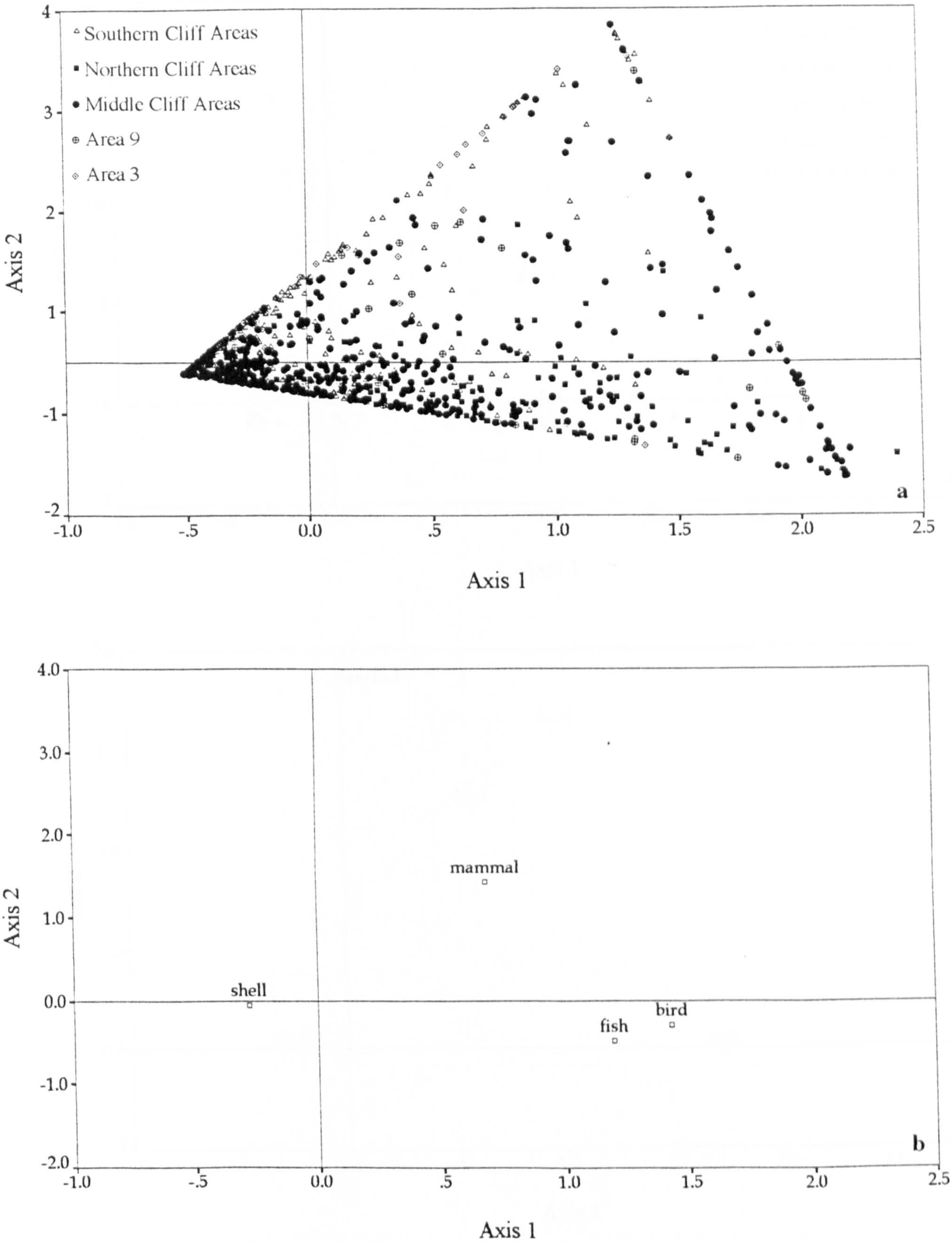
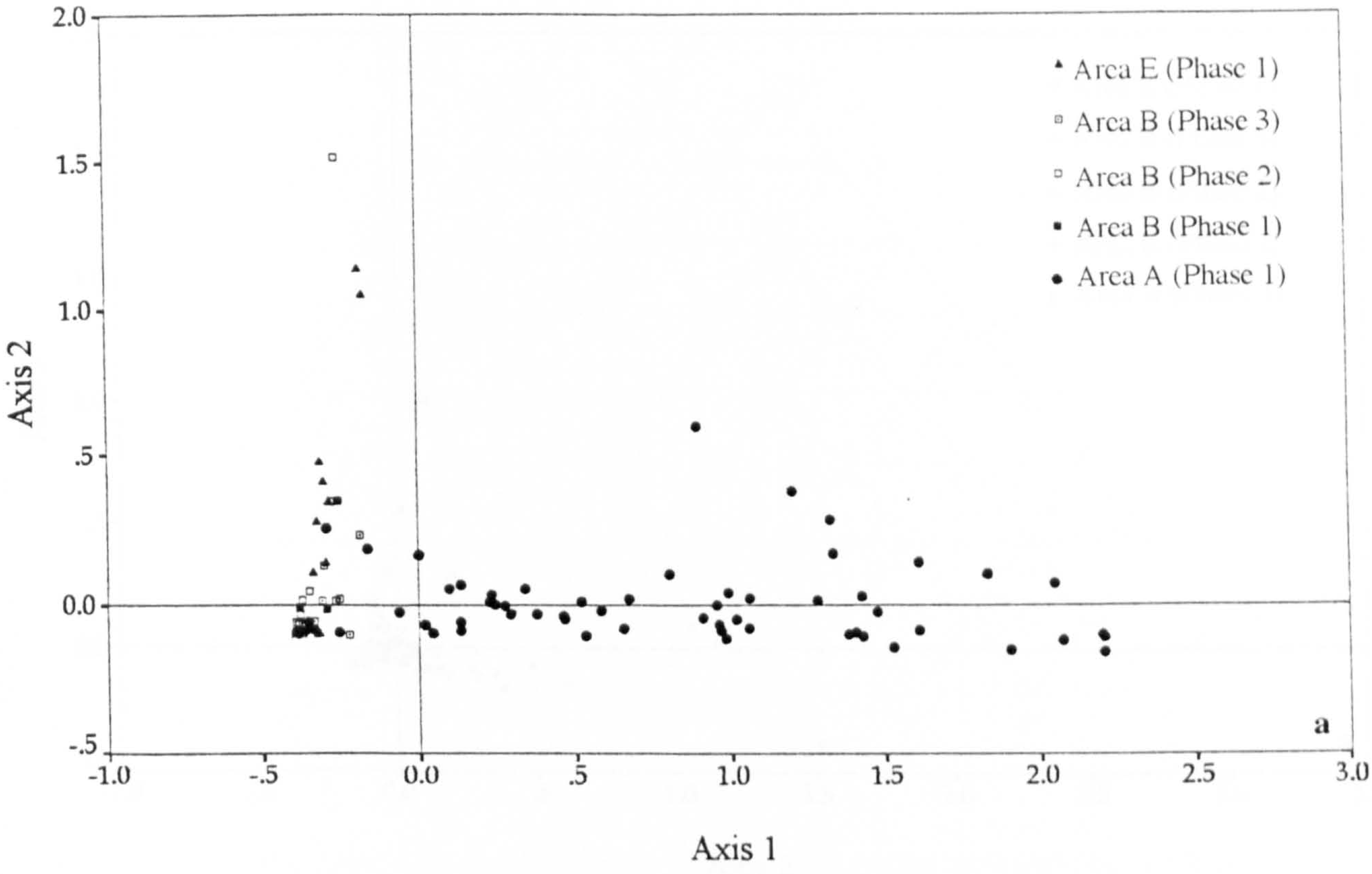


Figure 7.1. Axes 1 and 2 of a correspondence analysis of the weight of shell, fish bone, mammal bone and bird bone (sorted using the methods of Jones et al. forthcoming a) in 1016 samples from Freswick Links. Samples from hiatus strata have been omitted. Diagram a is the row plot for each sample (labeled by excavation area) while diagram b is the column plot for each material. Explanation on axes 1 and 2 is 59.1% and 35.7% respectively. Axis 1 has been stretched for ease of interpretation.



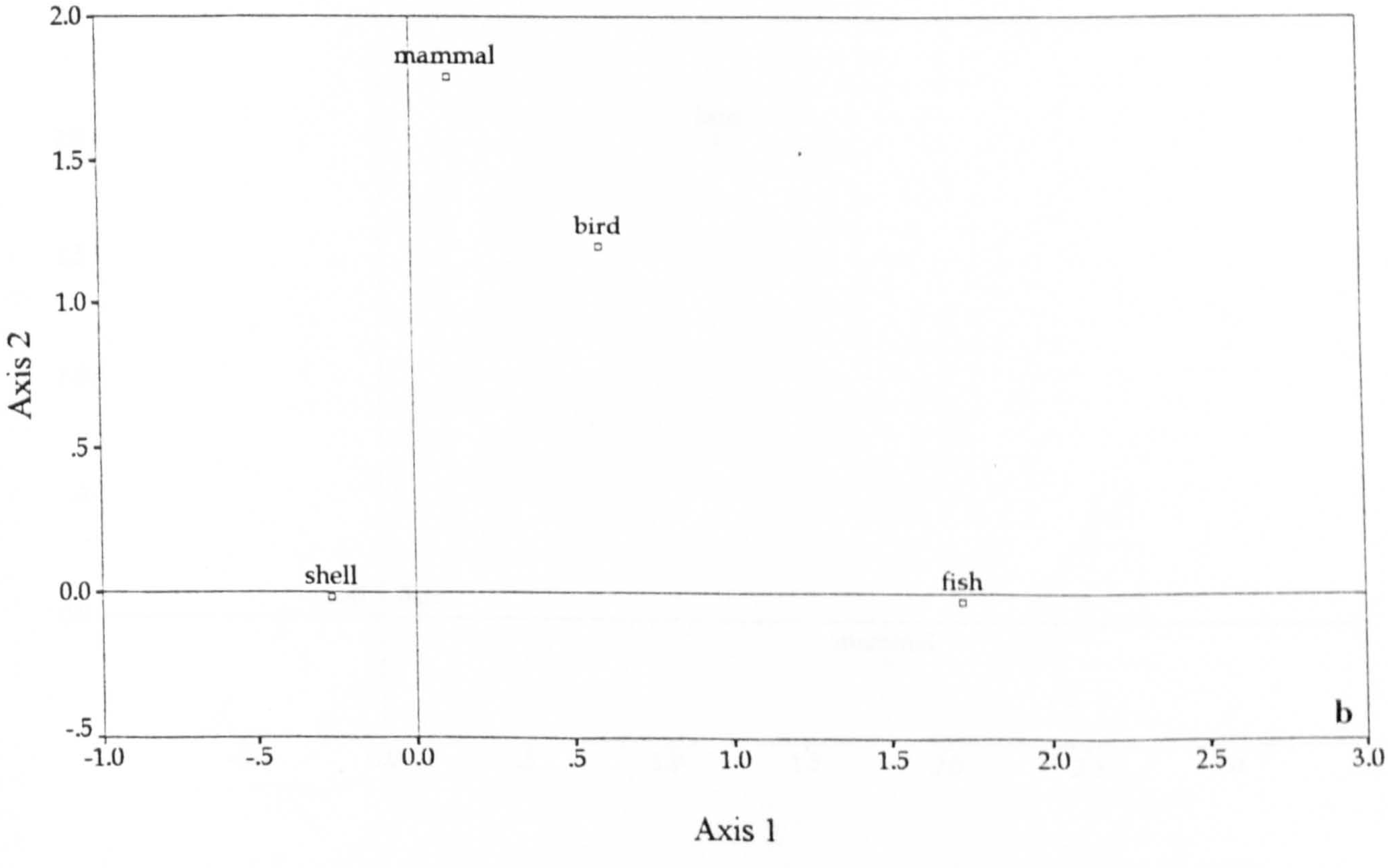
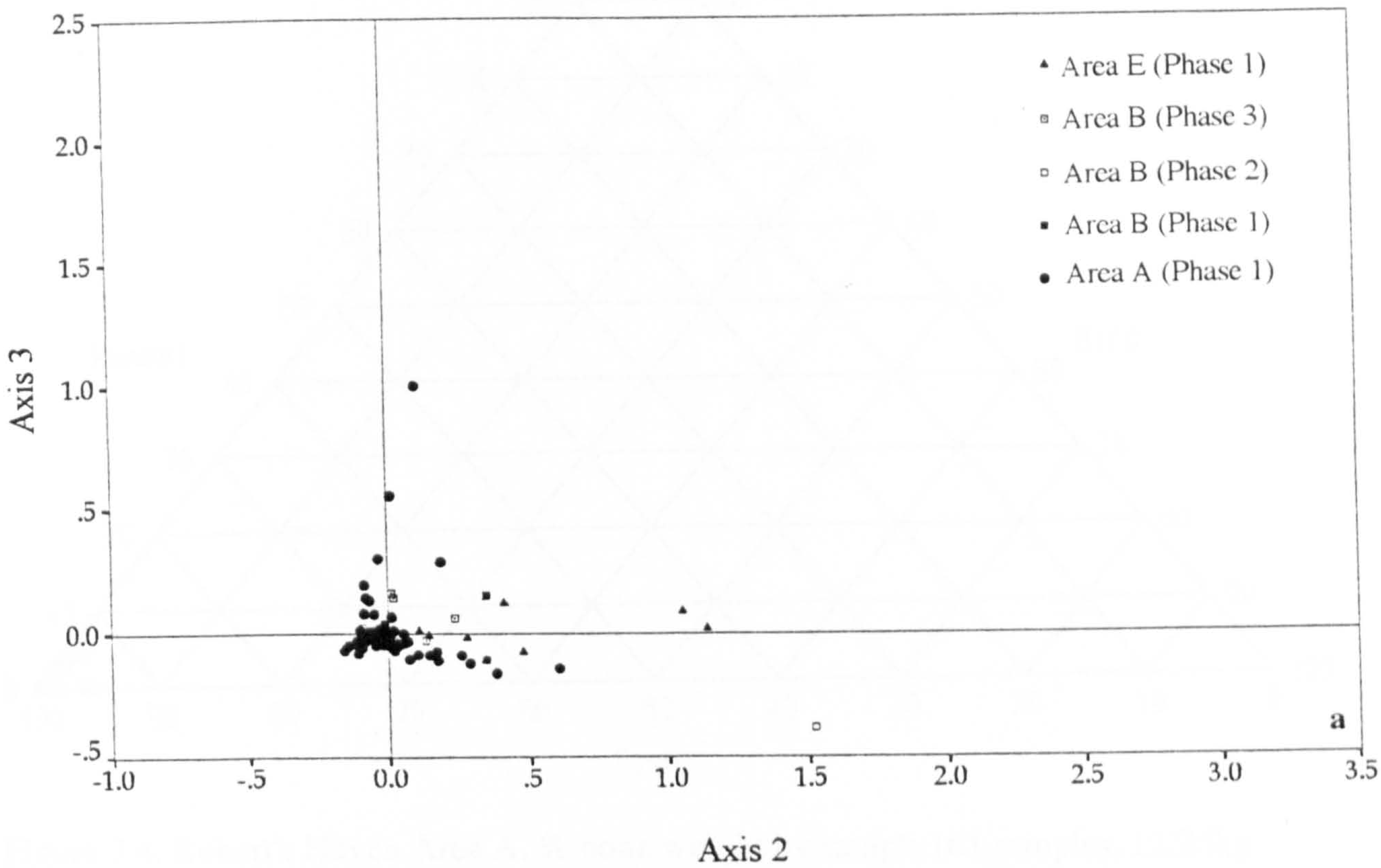


Figure 7.2. Axes 1 and 2 of a correspondence analysis of the weight of shell, fish bone, mammal bone and bird bone (completely sorted to 4mm) in 102 samples from Areas A, B and E at Robert's Haven. Samples from superficial deposits have been omitted. Diagram a is the row plot for each sample while diagram b is the column plot for each material. Explanation on axes 1 and 2 is 92.2% and 6.8% respectively.



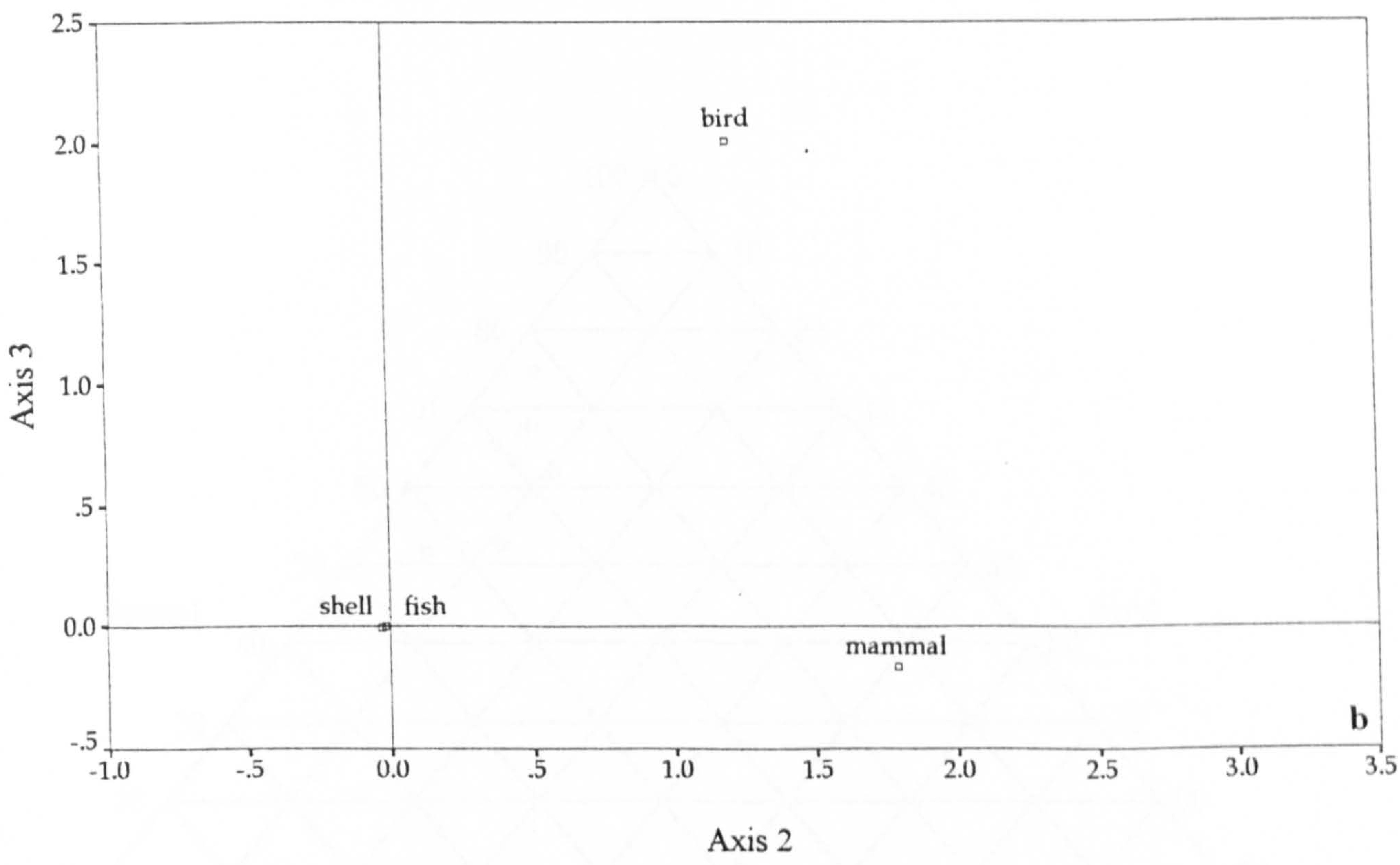


Figure 7.3. Axes 2 and 3 of a correspondence analysis of the weight of shell, fish bone, mammal bone and bird bone (completely sorted to 4mm) in 102 samples from Areas A, B and E at Robert's Haven. Samples from superficial deposits have been omitted. Diagram a is the row plot for each sample while diagram b is the column plot for each material. Explanation on axes 2 and 3 is 6.8% and 1.0% respectively.

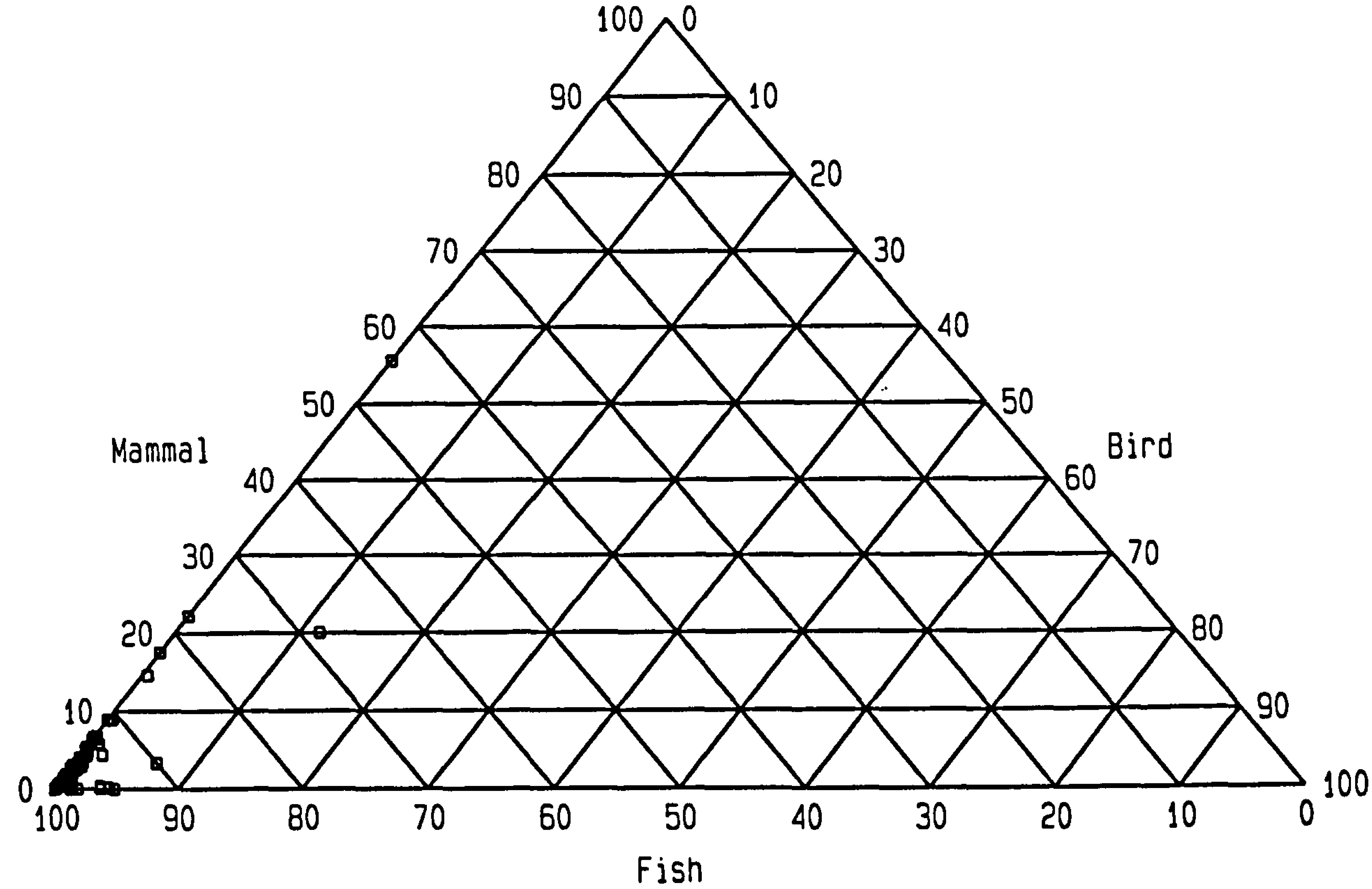


Figure 7.4. Robert's Haven Area A, % bone weight by sample (61 samples, 12.25kg bone, 916 litres sediment).

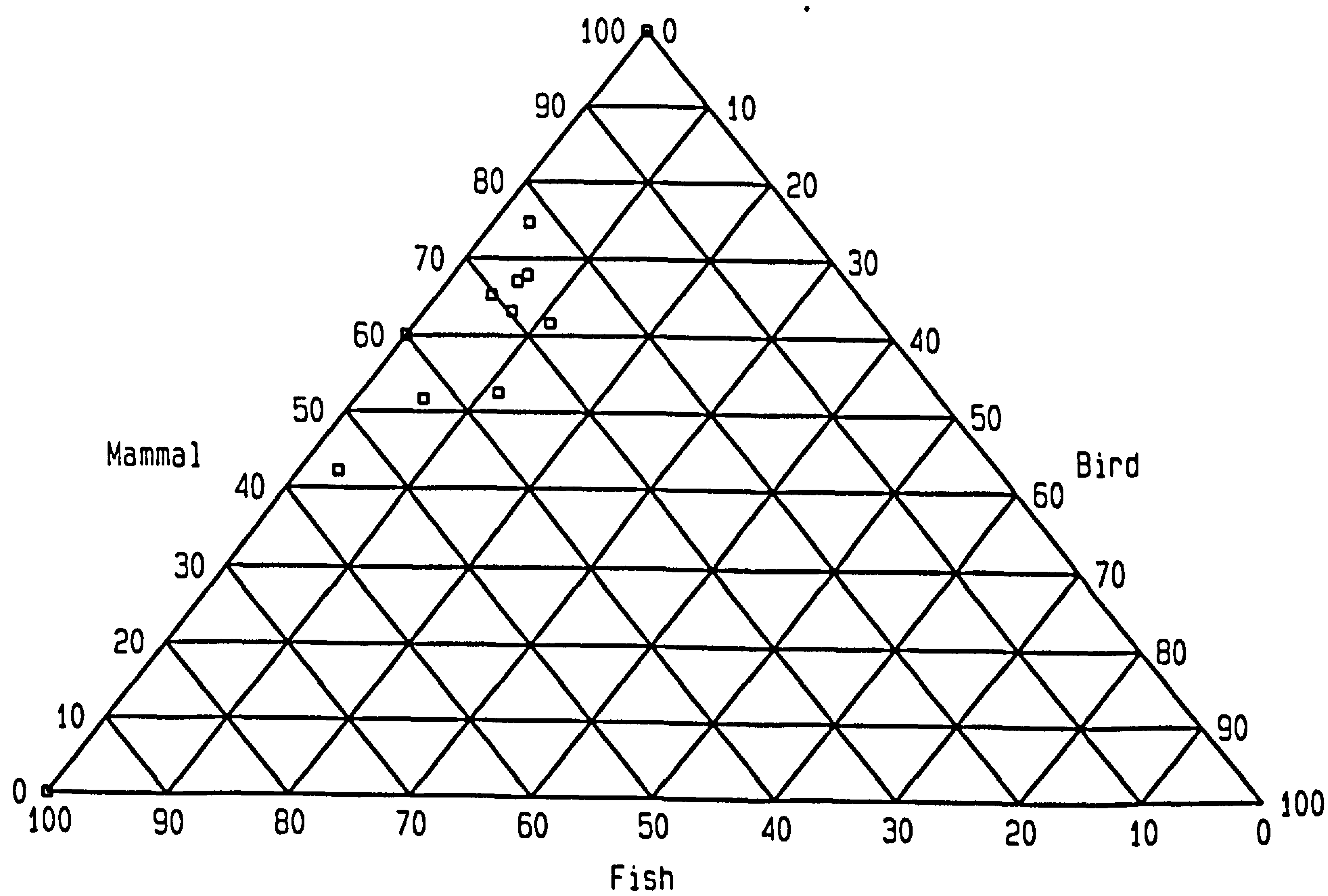


Figure 7.7. Robert's Haven Area E, % bone weight by sample (14 samples, 0.71kg bone, 996 litres sediment).

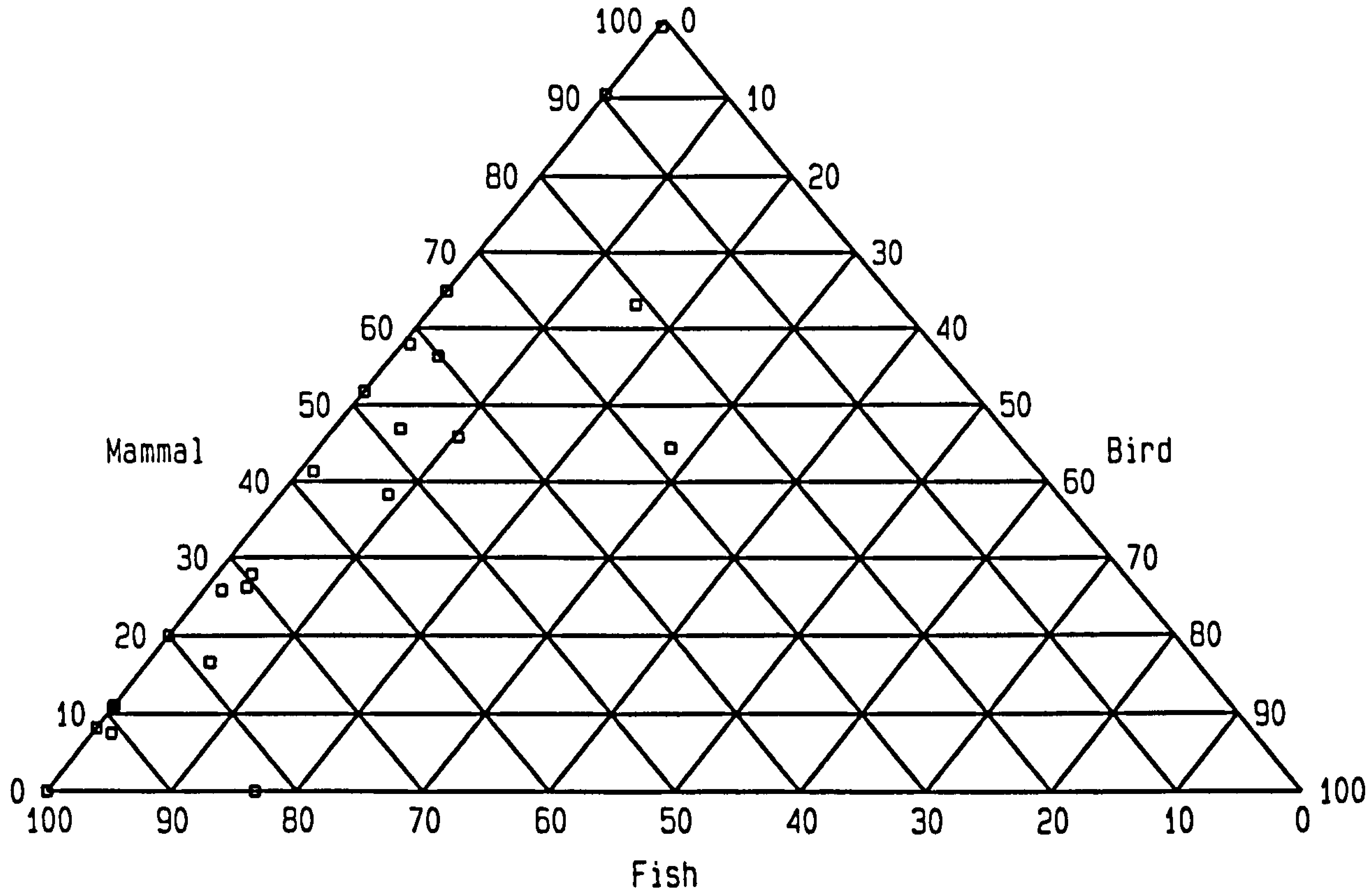


Figure 7.5. Robert's Haven Area B, Late Norse and Late Norse? phases, % bone weight by sample (23 samples, 0.40kg bone, 667 litres sediment).

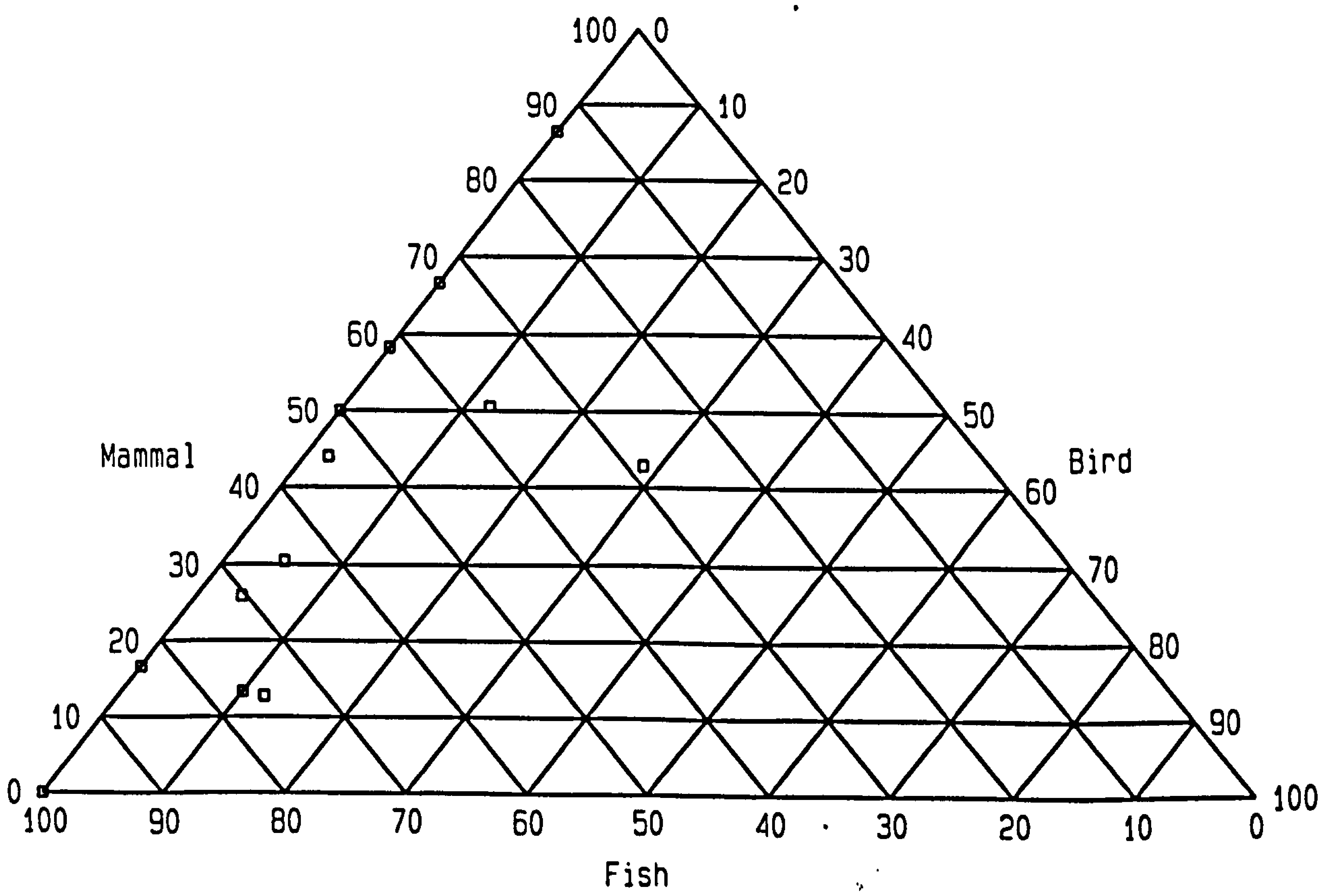


Figure 7.6. Robert's Haven Area B, post-medieval phase and superficial deposits, % bone weight by sample (20 samples, 0.11kg bone, 265 litres sediment).

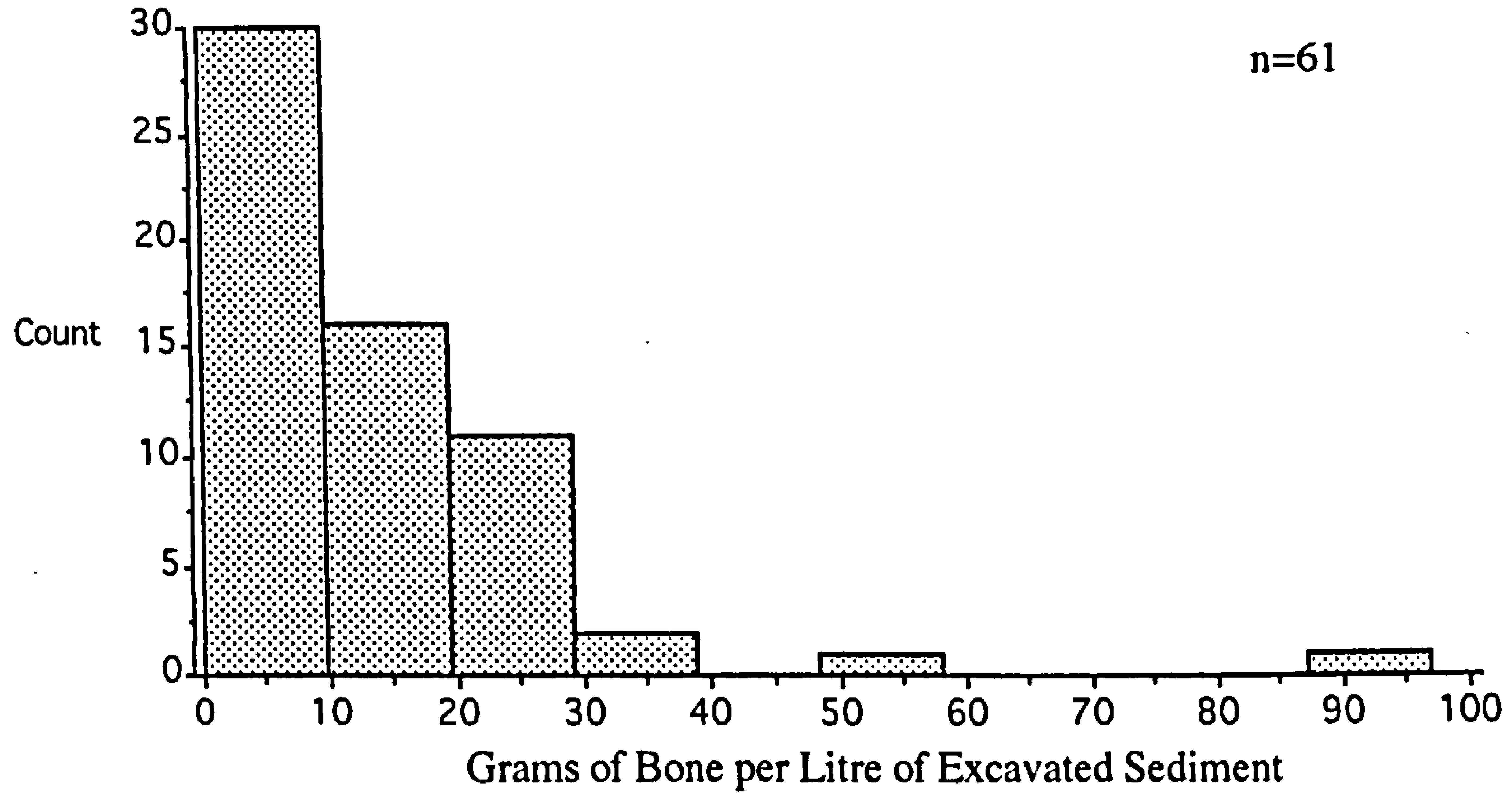


Figure 7.8. Robert's Haven Area A, density of bone inclusions per kg of sediment (mean: 13.3g/l).

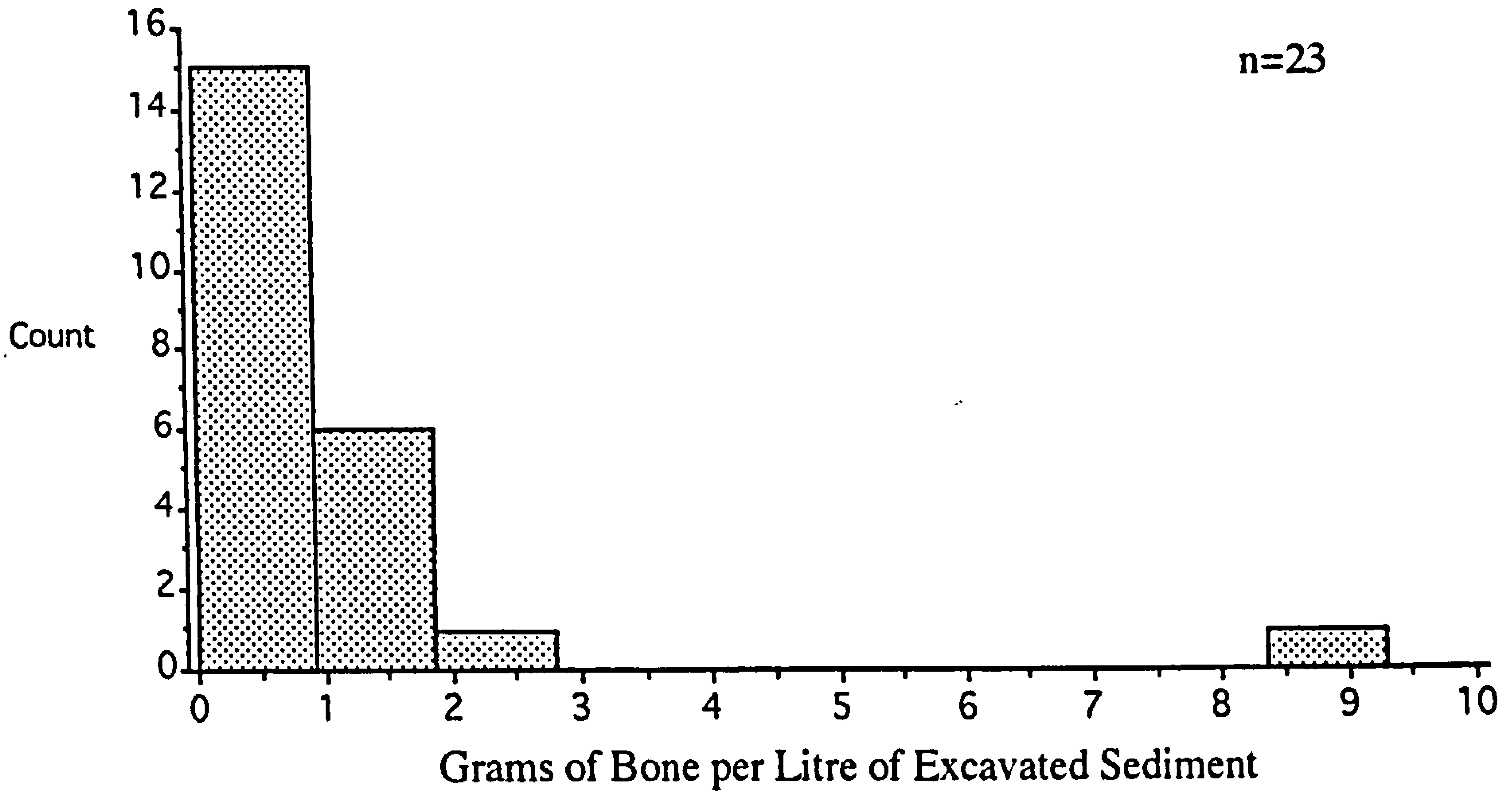


Figure 7.9. Robert's Haven Area B, Late Norse and Late Norse? phases, density of bone inclusions per kg of sediment (mean: 1.0g/l).

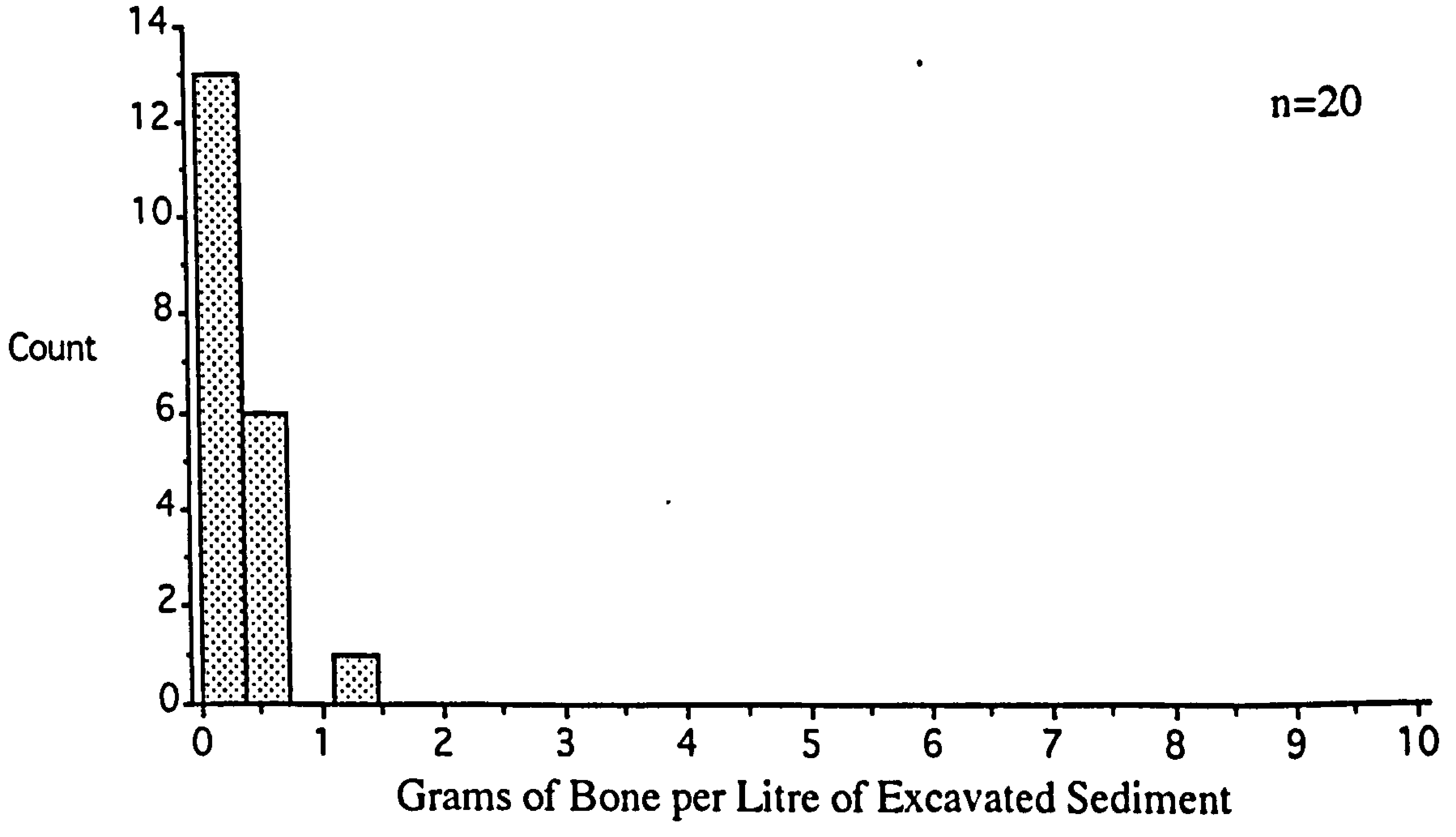


Figure 7.10. Robert's Haven Area B, post-medieval phase and superficial deposits, density of bone inclusions per kg of sediment (mean: 0.3g/l).

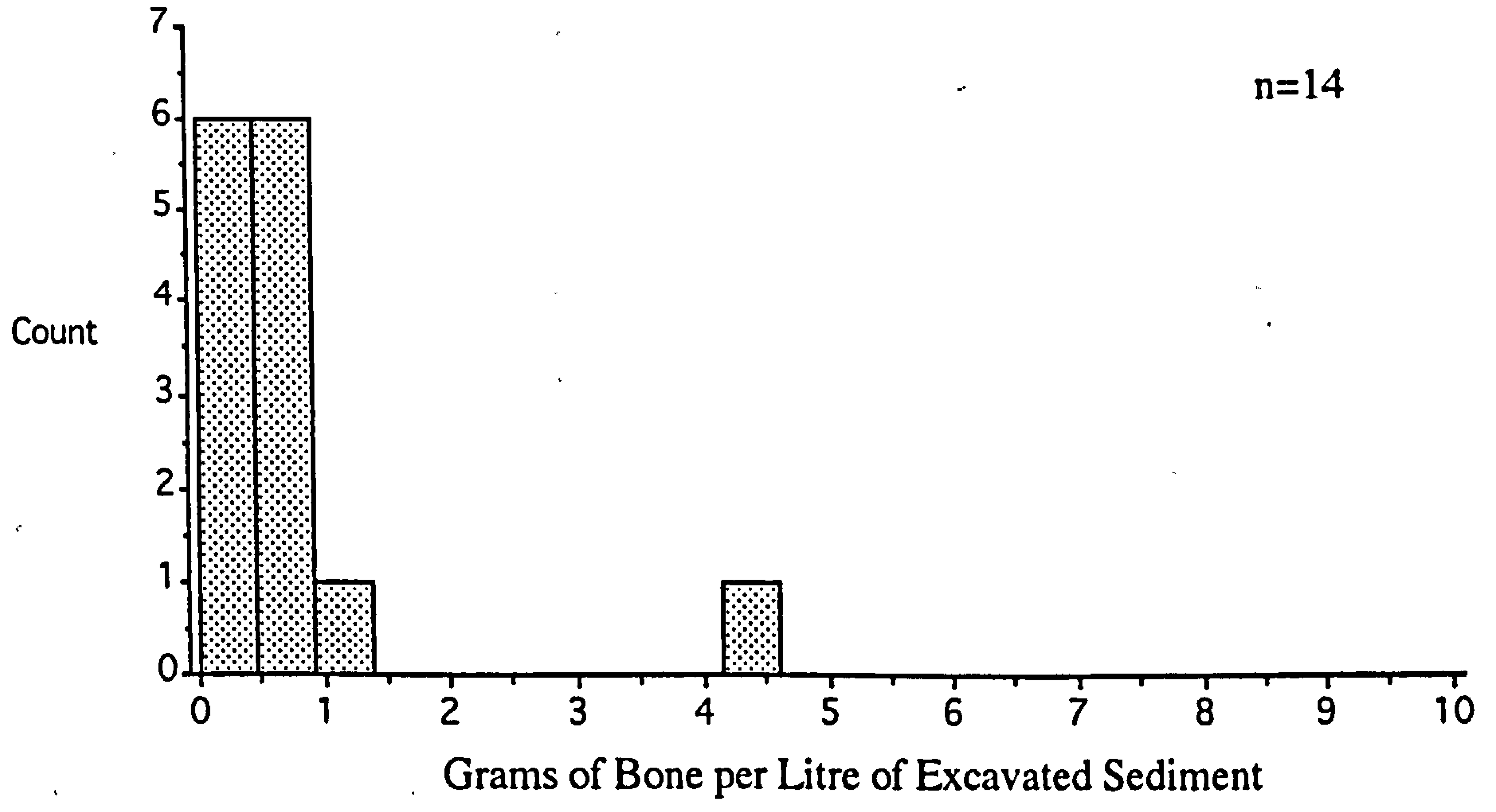


Figure 7.11. Robert's Haven Area E, density of bone inclusions per kg of sediment (mean: 0.7g/l).

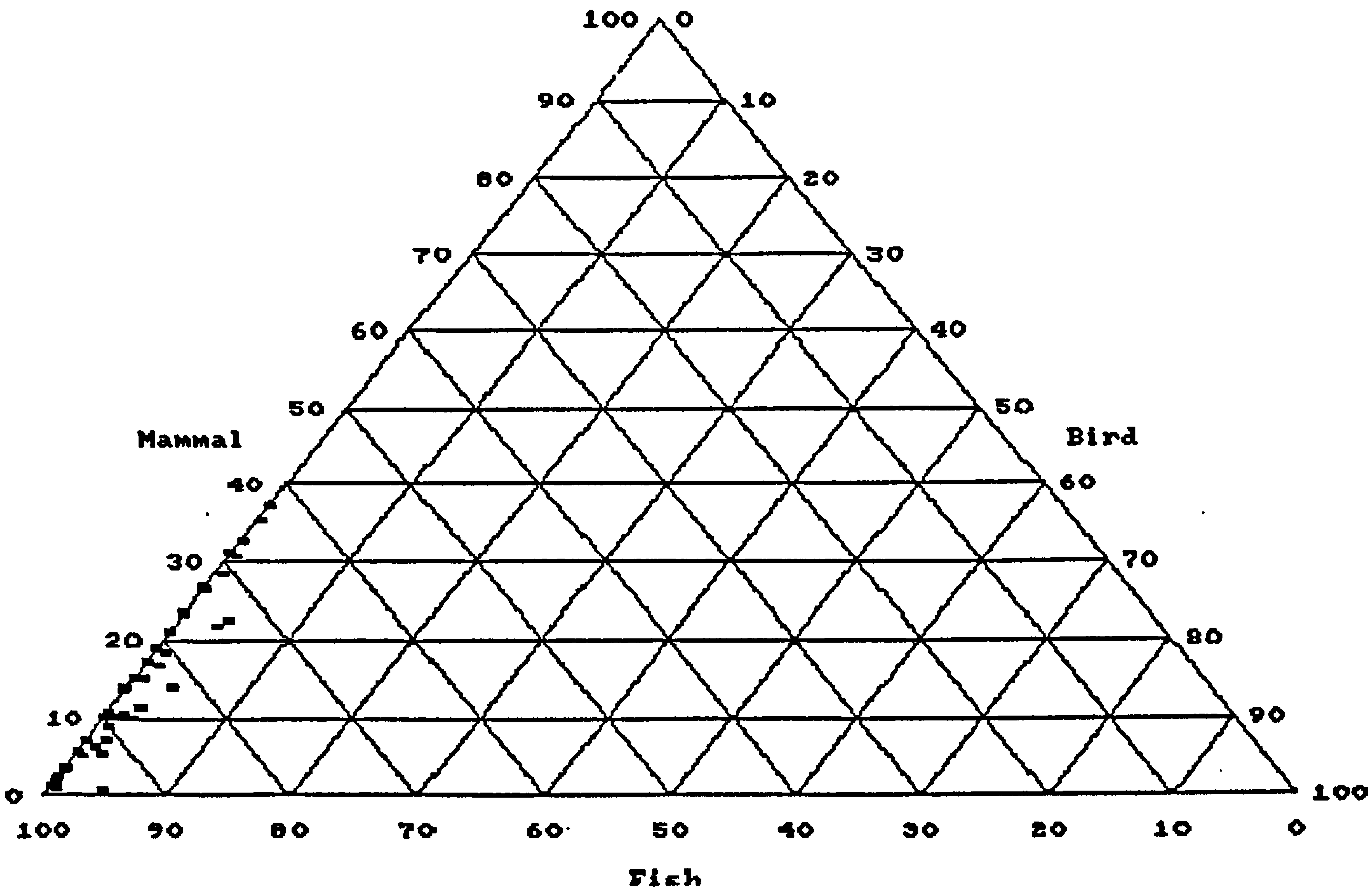


Figure 7.12. Freswick Links Northern Cliff Areas (Area 4), % bone weight by sample for 47 samples resorted to 4mm (11.09kg bone, 1820 litres sediment).

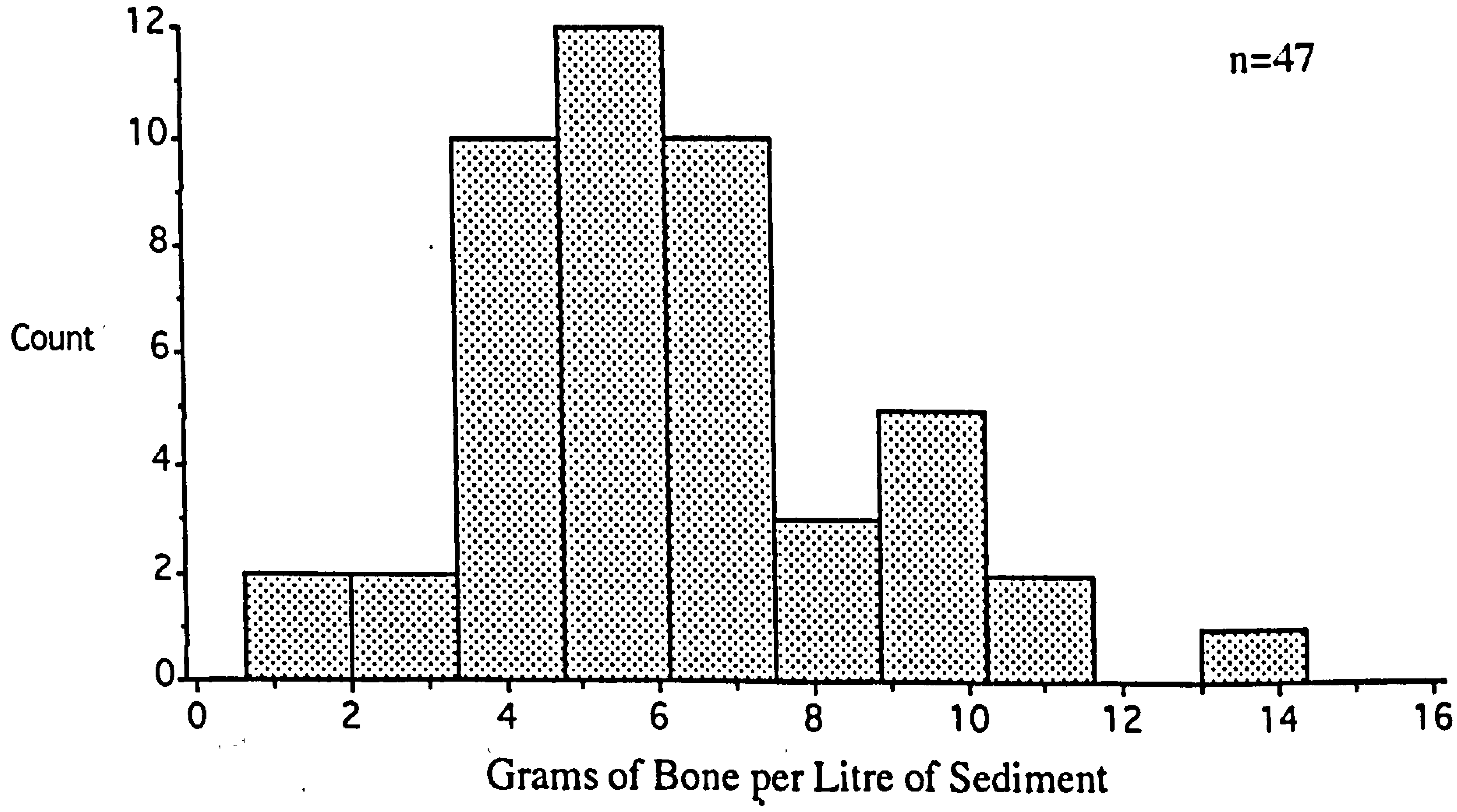


Figure 7.13. Freswick Links Northern Cliff Areas (Area 4), density of bone inclusions per kg of sediment for 47 samples resorted to 4mm (mean: 6.1g/l).

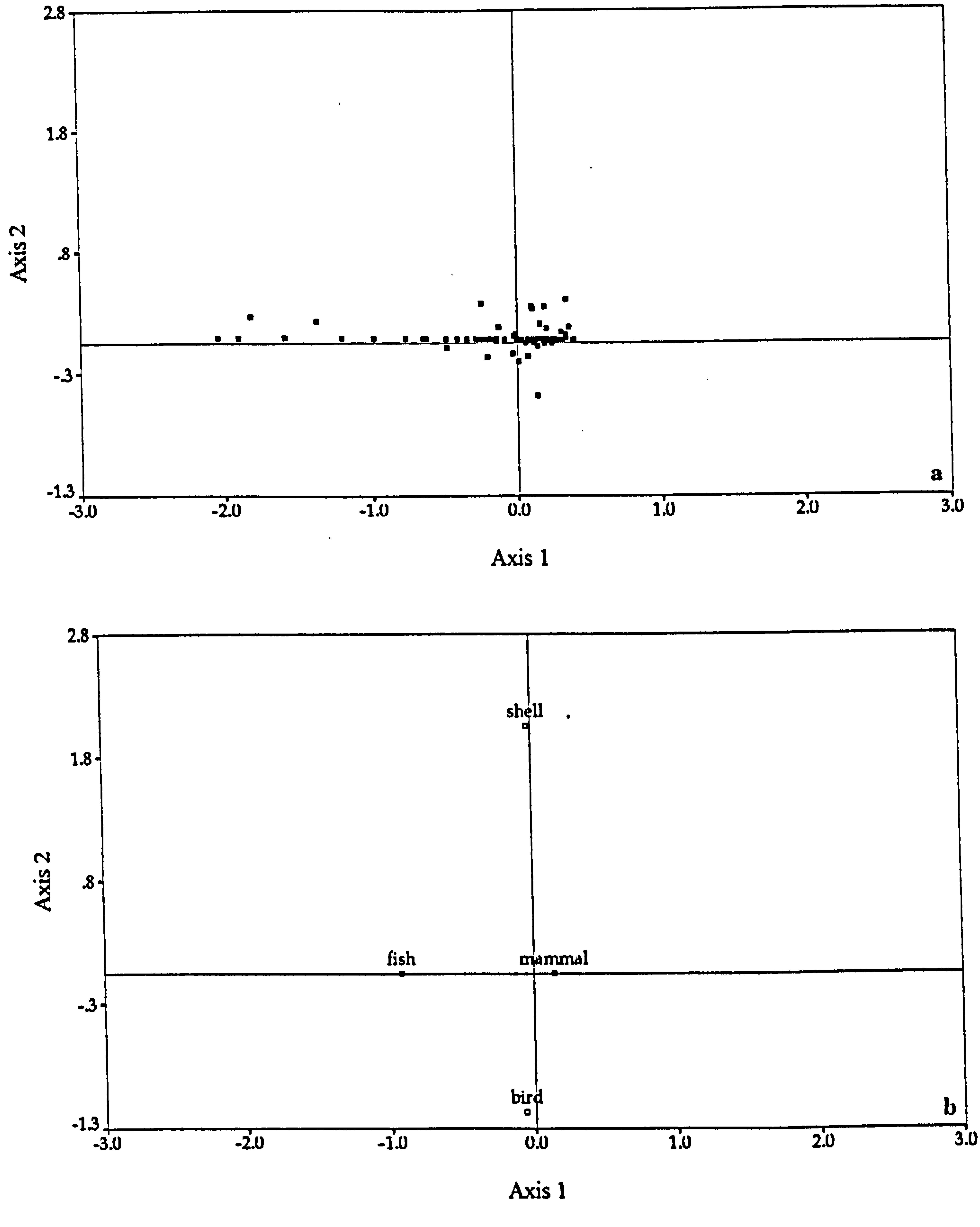


Figure 7.14. Axes 1 and 2 of a correspondence analysis of the weight of shell, fish bone, mammal bone and bird bone (completely sorted to 4mm) in 70 Late Norse samples from Earl's Bu. Samples from contexts with >10% of bone recovered by hand collecting are omitted. Diagram a is the row plot for each sample while diagram b is the column plot for each material. Explanation on axes 1 and 2 is 88.9% and 6.6% respectively (data from this study and Mainland pers comm.).

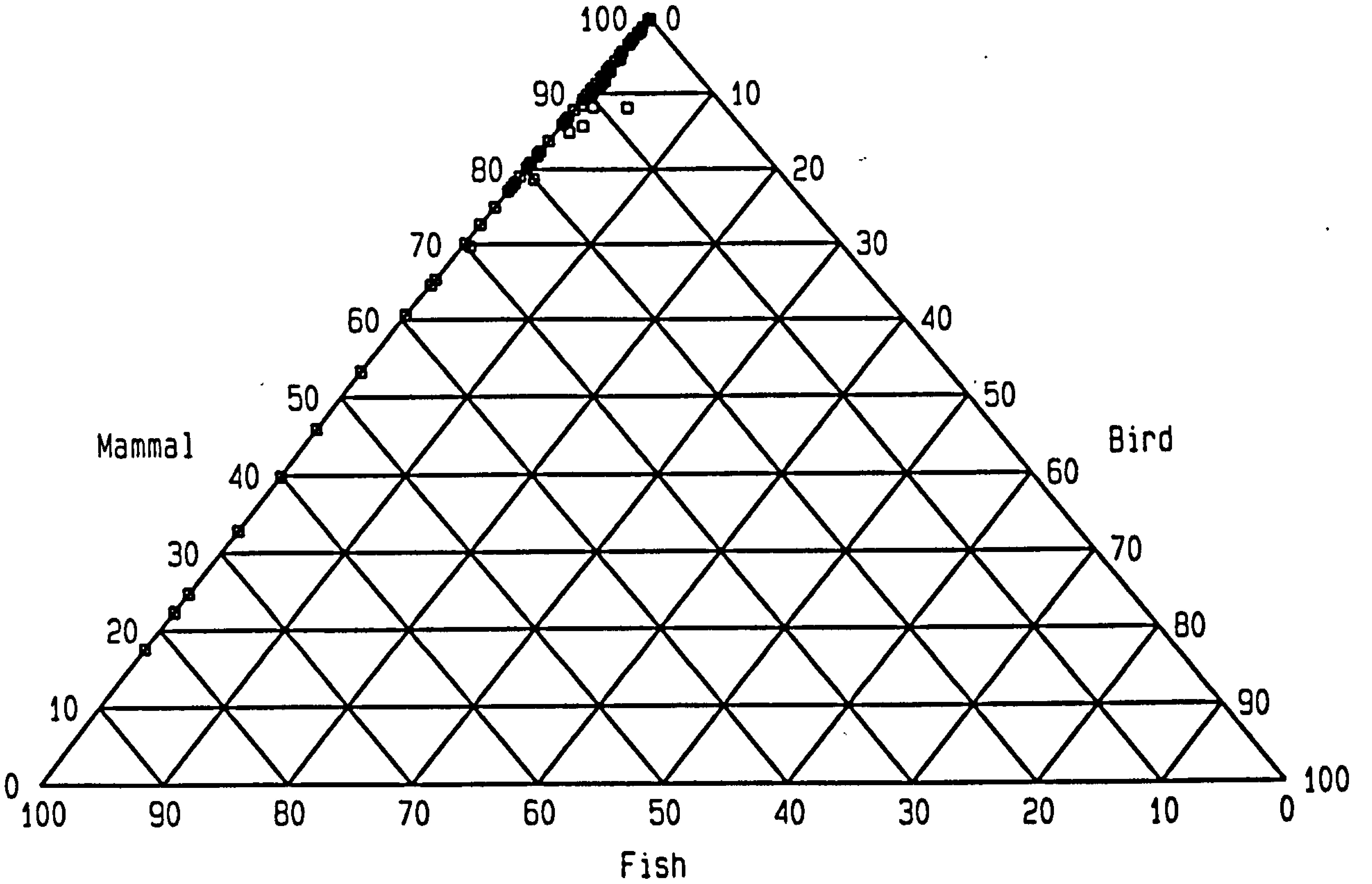


Figure 7.15. Earl's Bu, % bone weight by class in 70 Late Norse samples (25.88kg bone, >3058 litres sediment [volume data missing for three samples]) (data from this study and Mainland pers comm.).

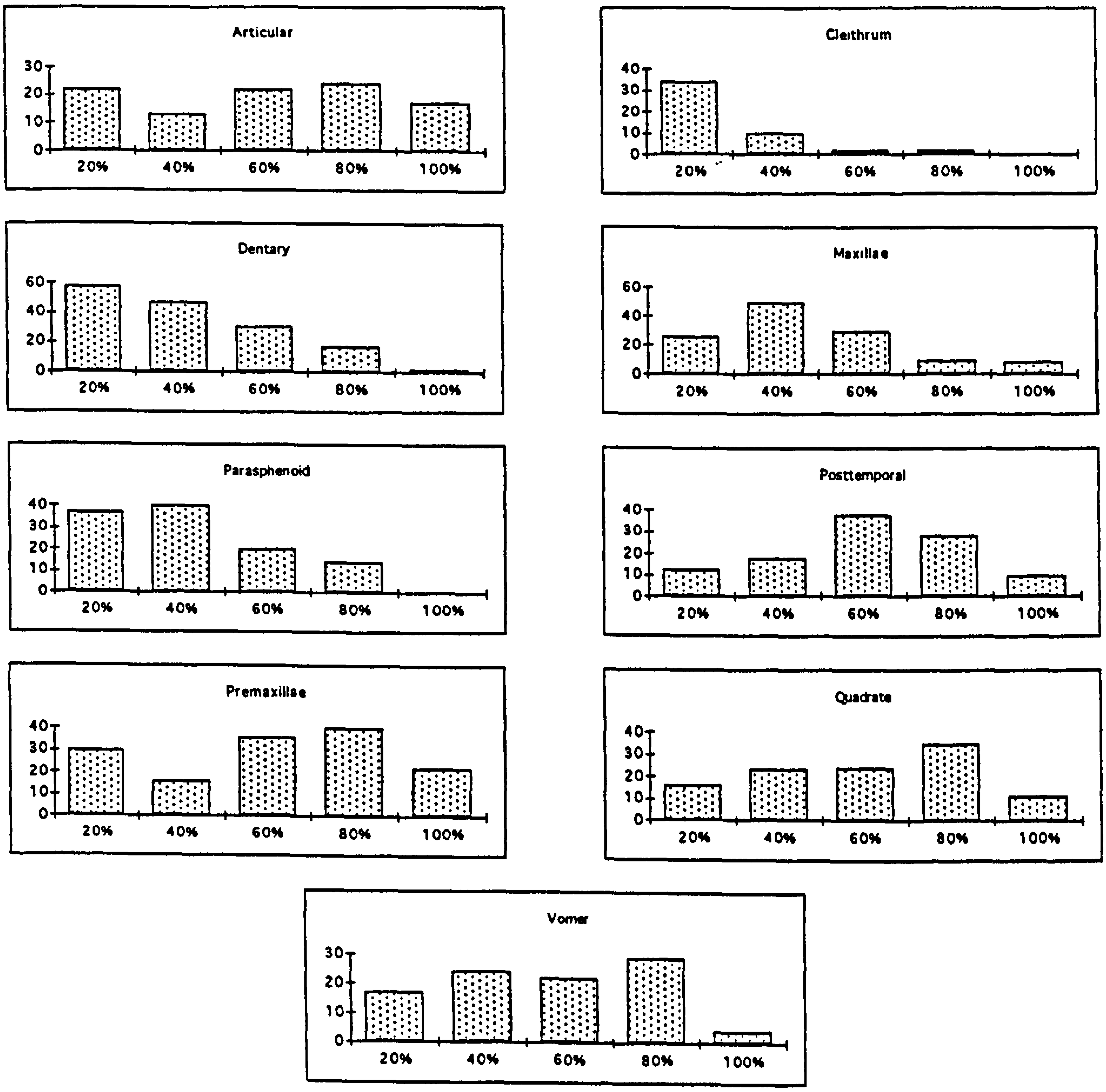


Figure 7.16. Robert's Haven Area A, completeness scores for nine cod elements.

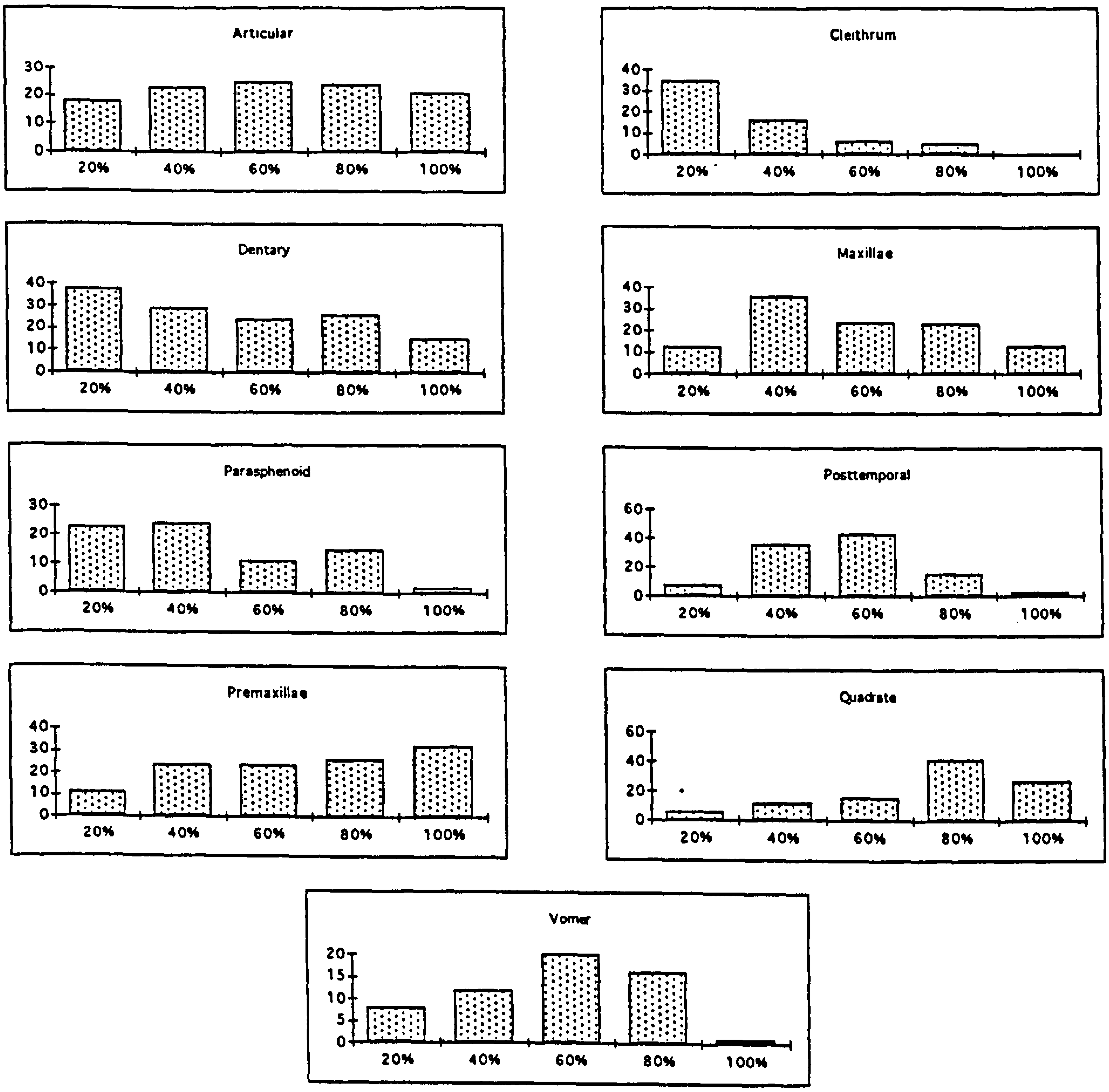


Figure 7.17. Robert's Haven Area A, completeness scores for nine saith elements.

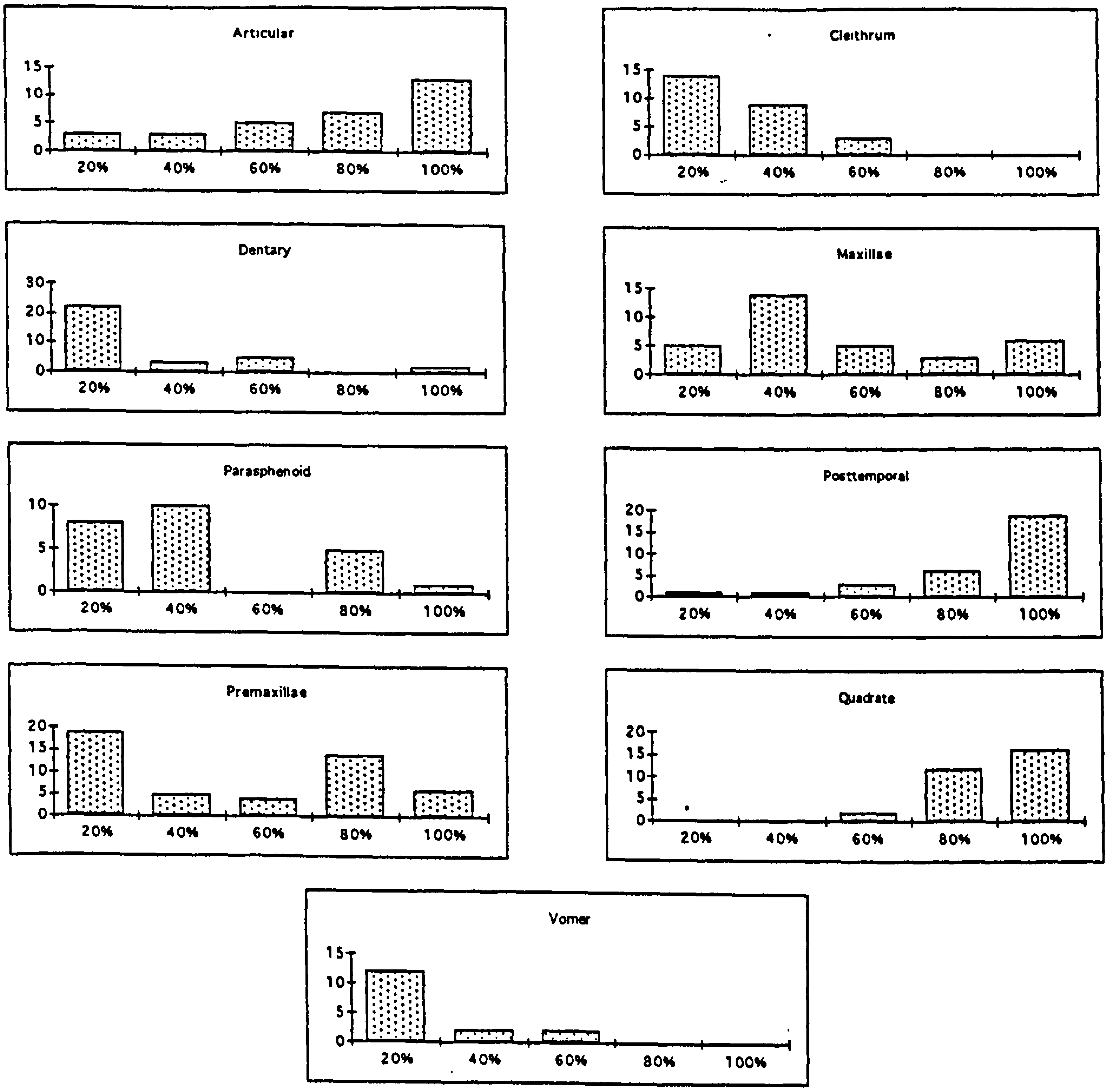


Figure 7.18. Robert's Haven Area A, completeness scores for nine ling elements.

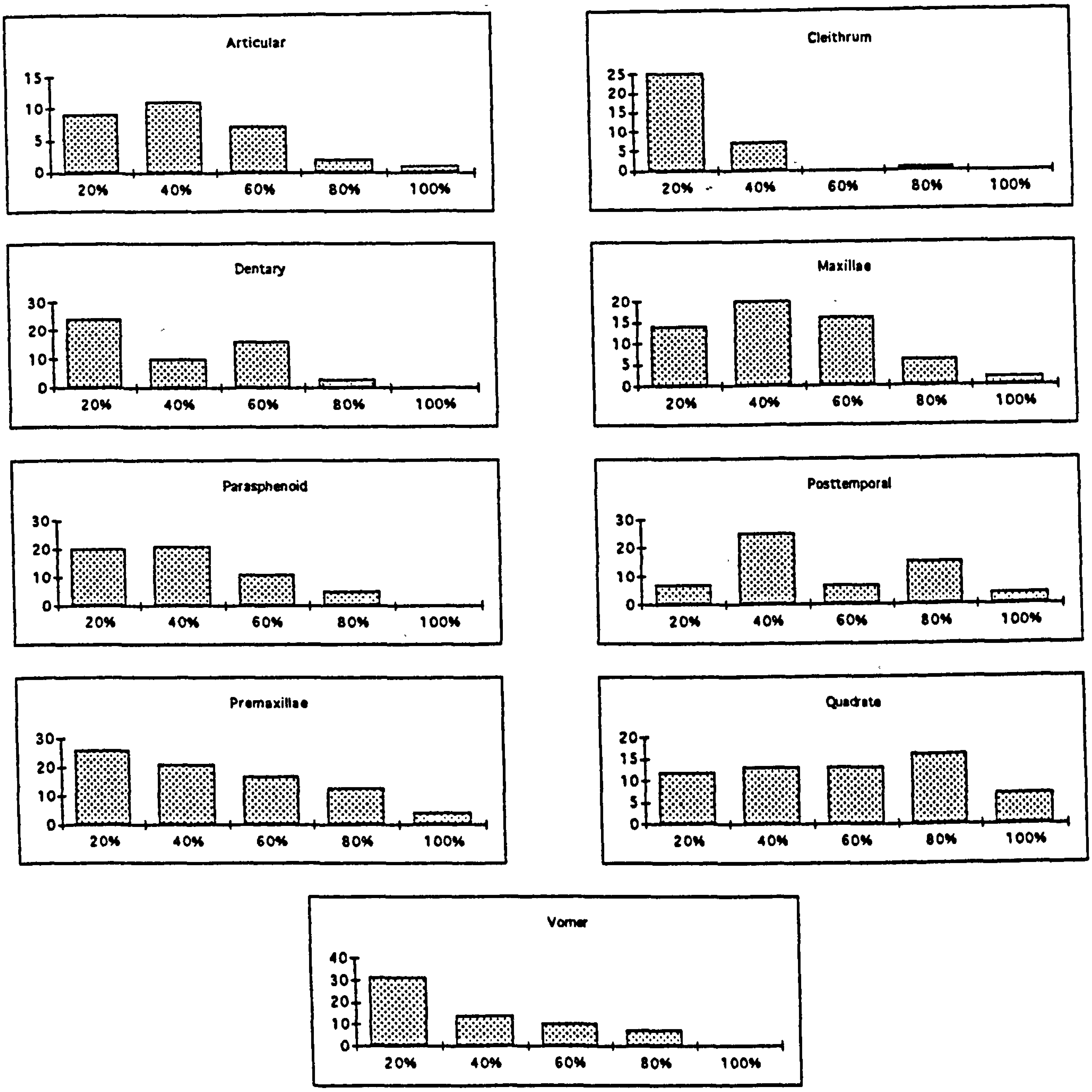


Figure 7.19. Earl's Bu, completeness scores for nine cod elements.

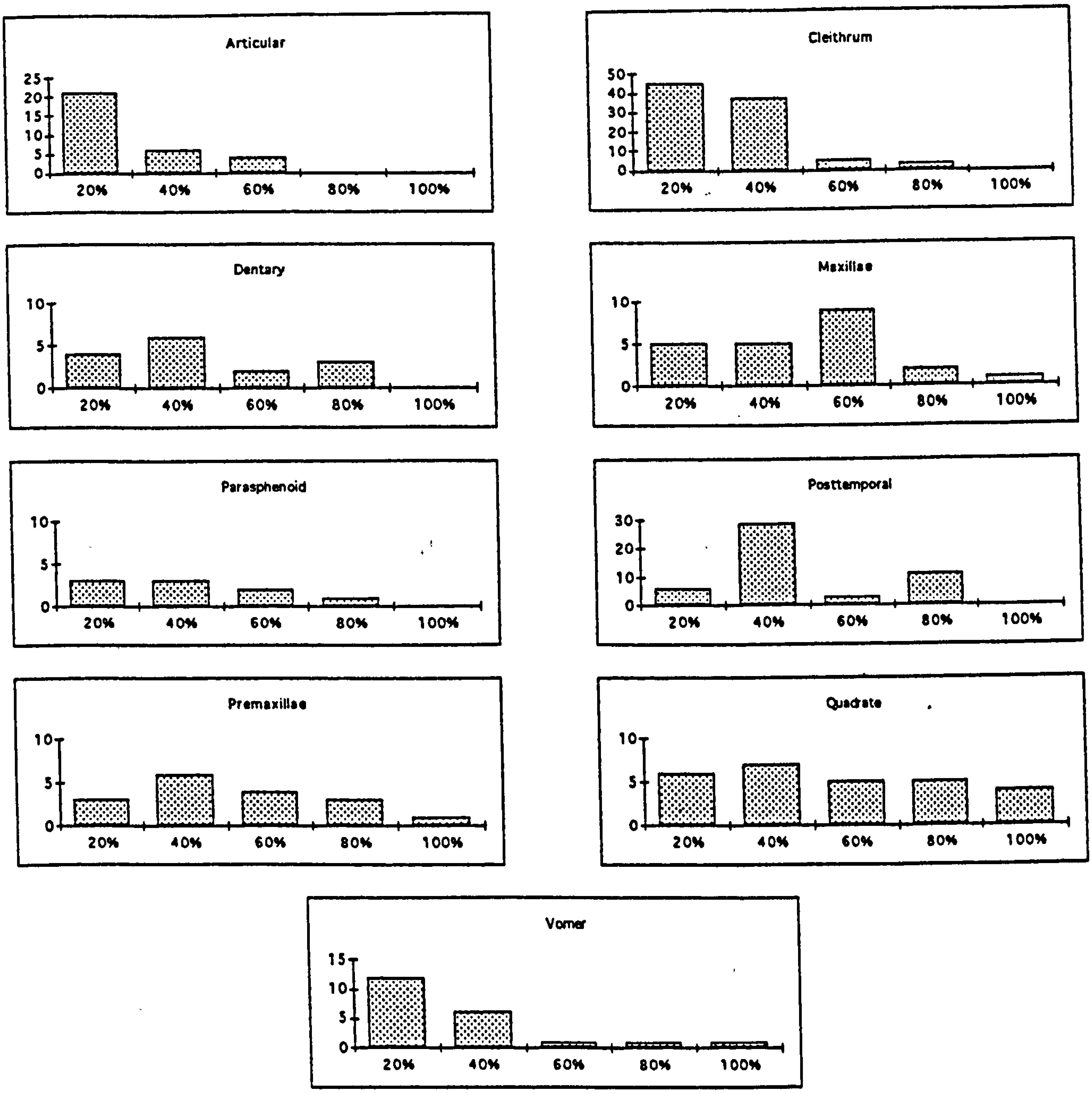


Figure 7.20. Earl's Bu, completeness scores for nine haddock elements.

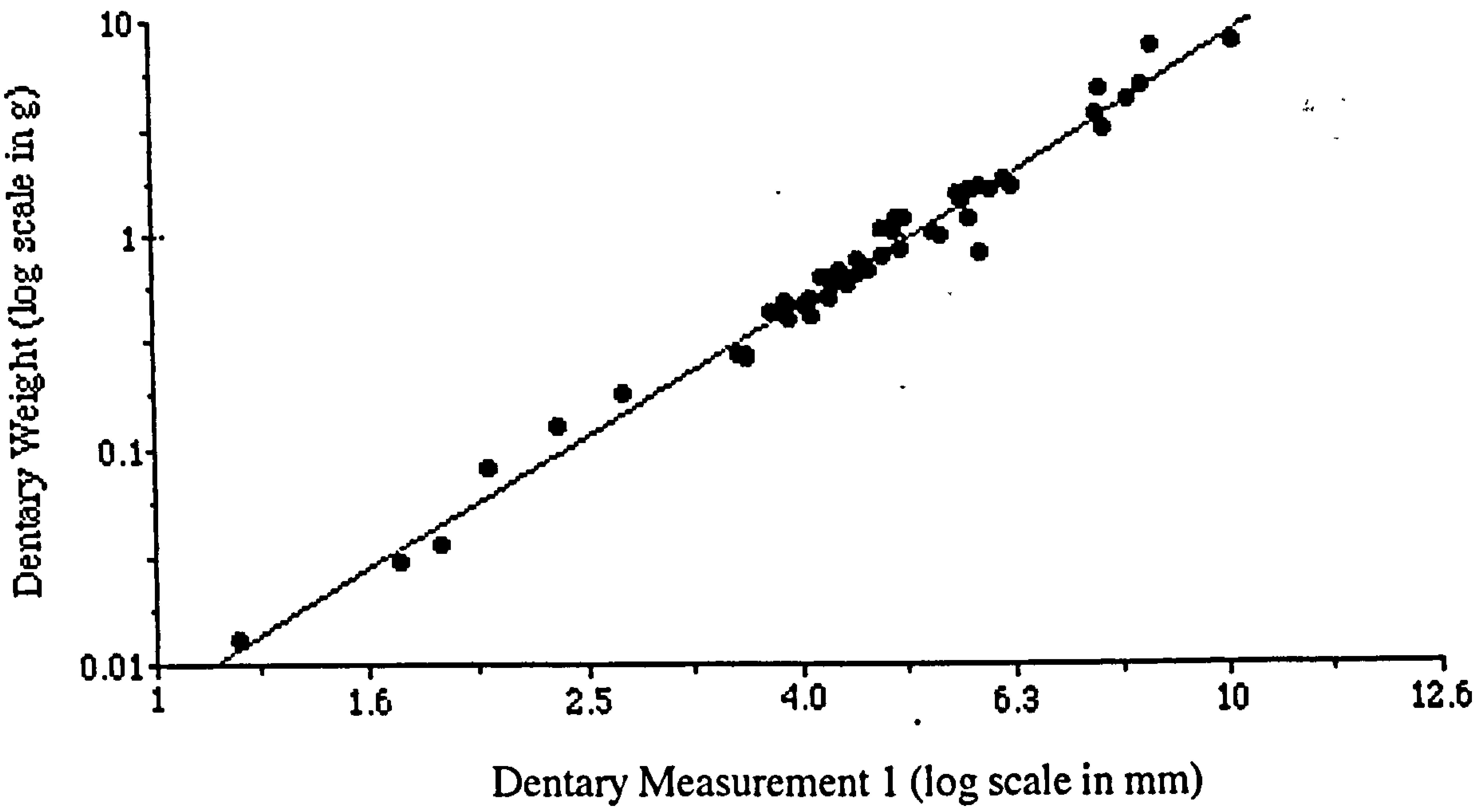


Figure 7.21. Best-fit line relating dentary measurement 1 and complete dentary weight for cod: Dentary Weight = $0.00697(D1)^{3.062}$ (n=54, r^2=0.98, p=<0.001).

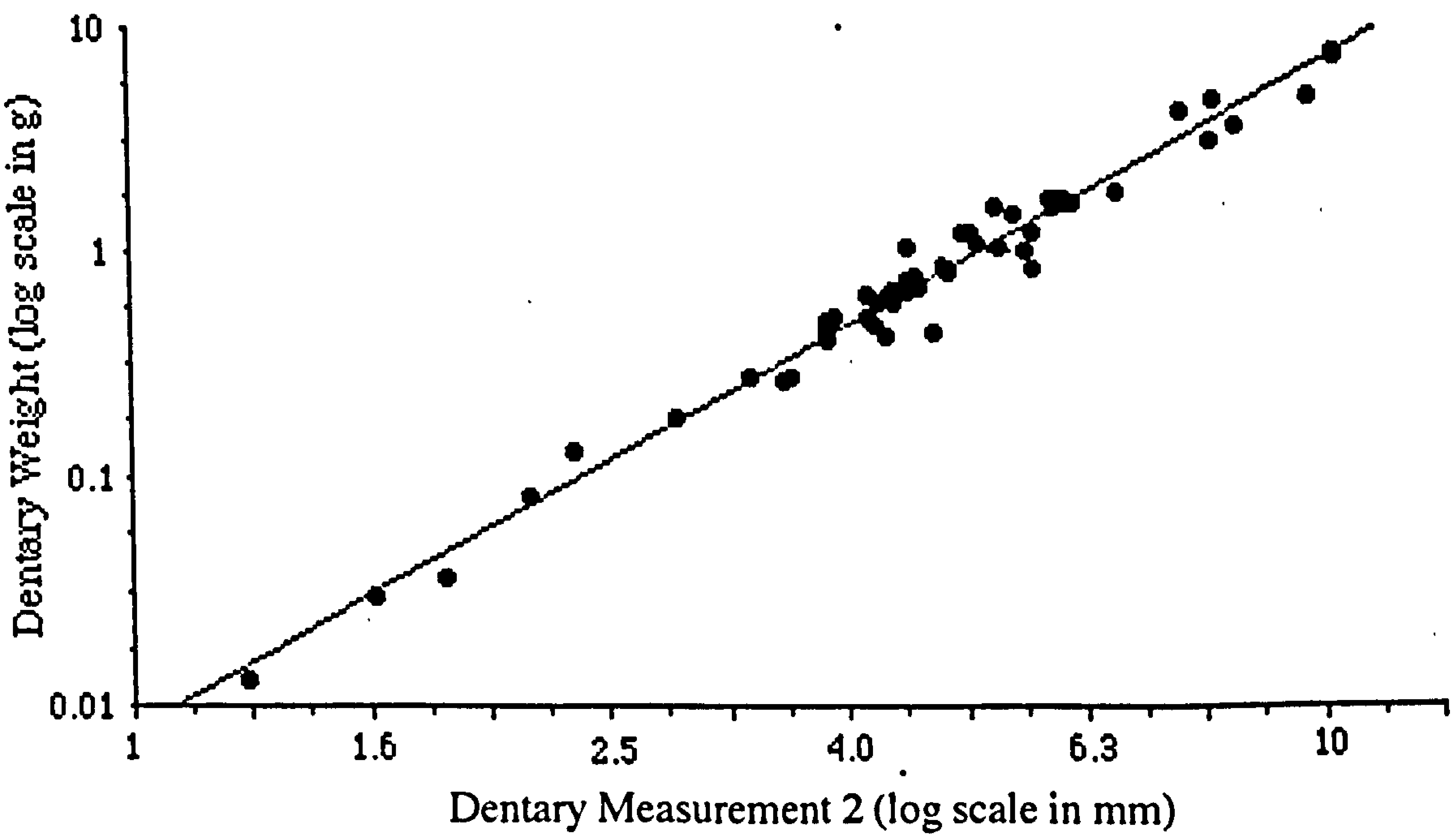


Figure 7.22. Best-fit line relating dentary measurement 2 and complete dentary weight for cod: Dentary Weight = $0.00791(D2)^{2.947}$ (n=54, r^2=0.98, p=<0.001).

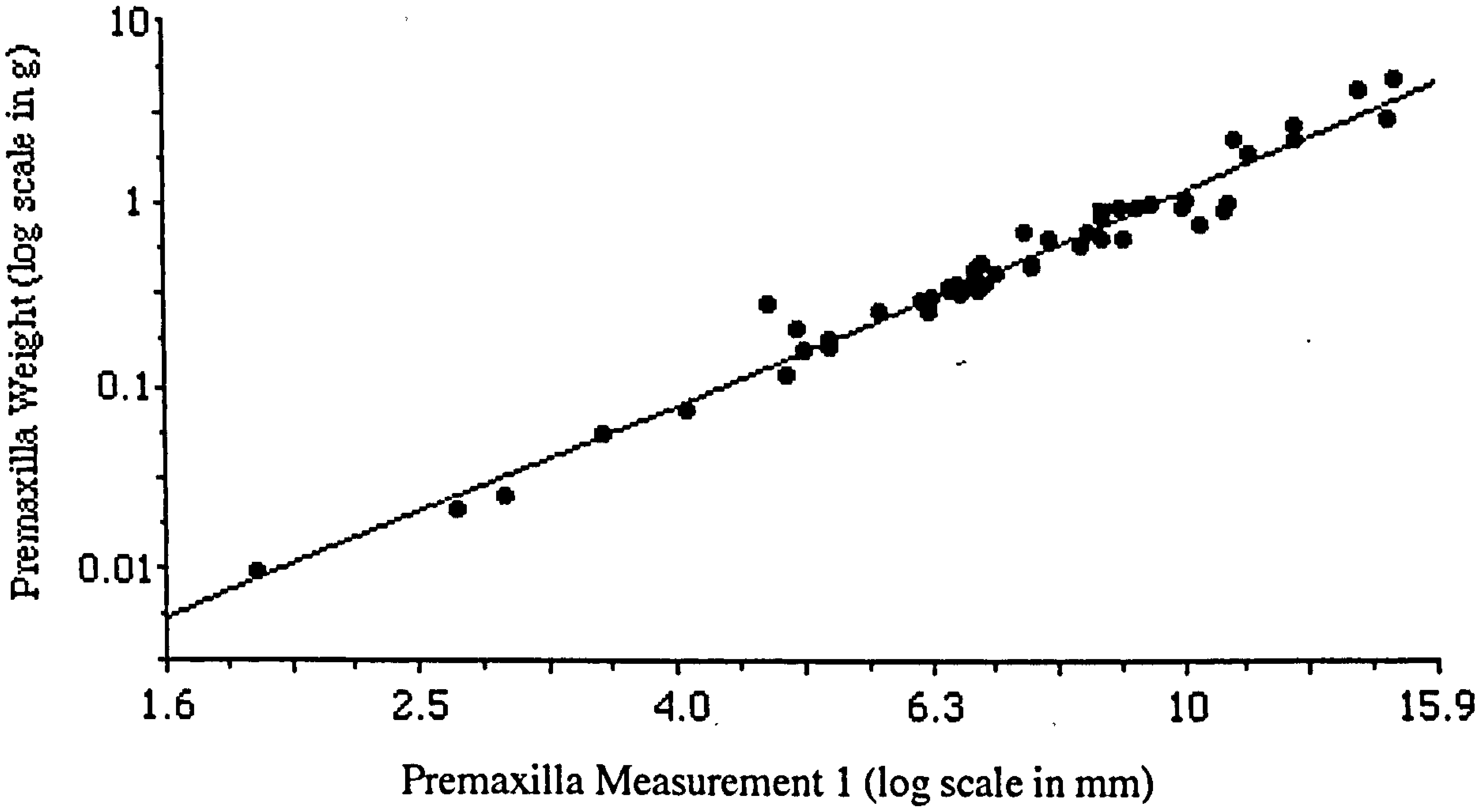


Figure 7.23. Best-fit line relating premaxilla measurement 1 and complete premaxilla weight for cod: Premaxilla Weight = $0.00143(P1)^{2.914}$ (n=54, r^2=0.97, p=<0.001).

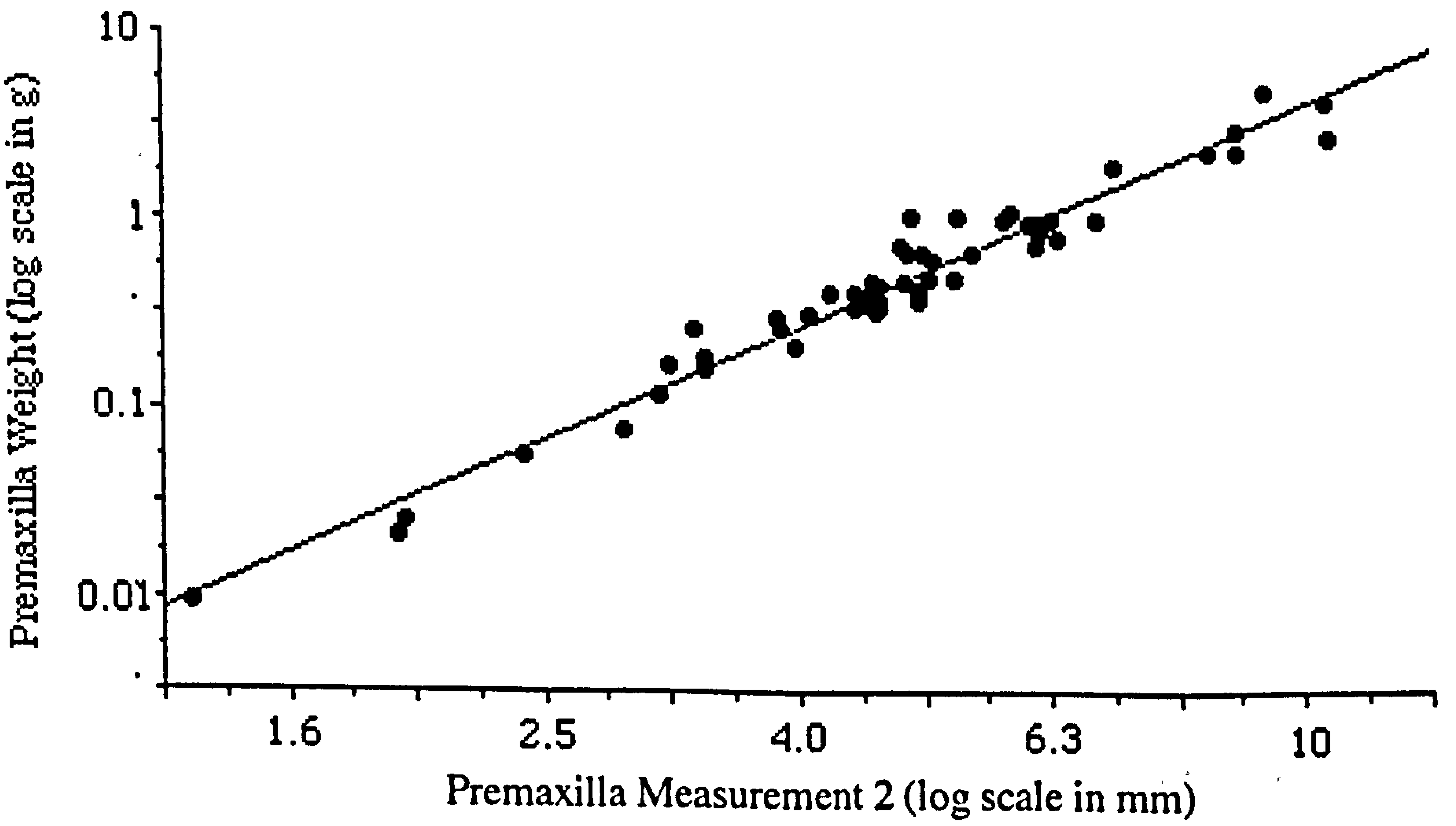


Figure 7.24. Best-fit line relating premaxilla measurement 2 and complete premaxilla weight for cod: Premaxilla Weight = $0.00447(P2)^{2.953}$ (n=53, r^2=0.96, p=<0.001).

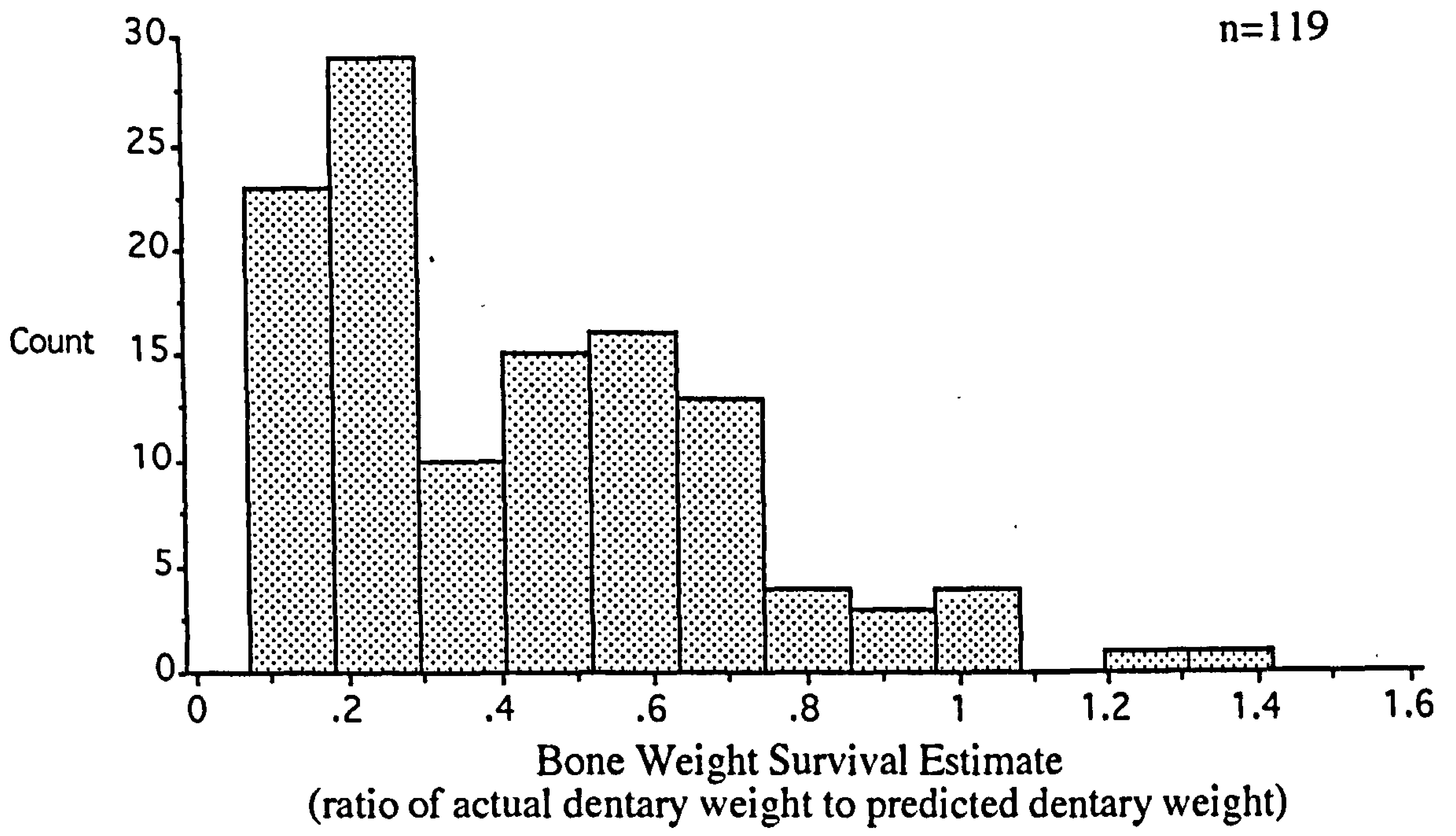


Figure 7.25. Robert's Haven, Area A, distribution of Bone Weight Survival Estimates for dentaries.

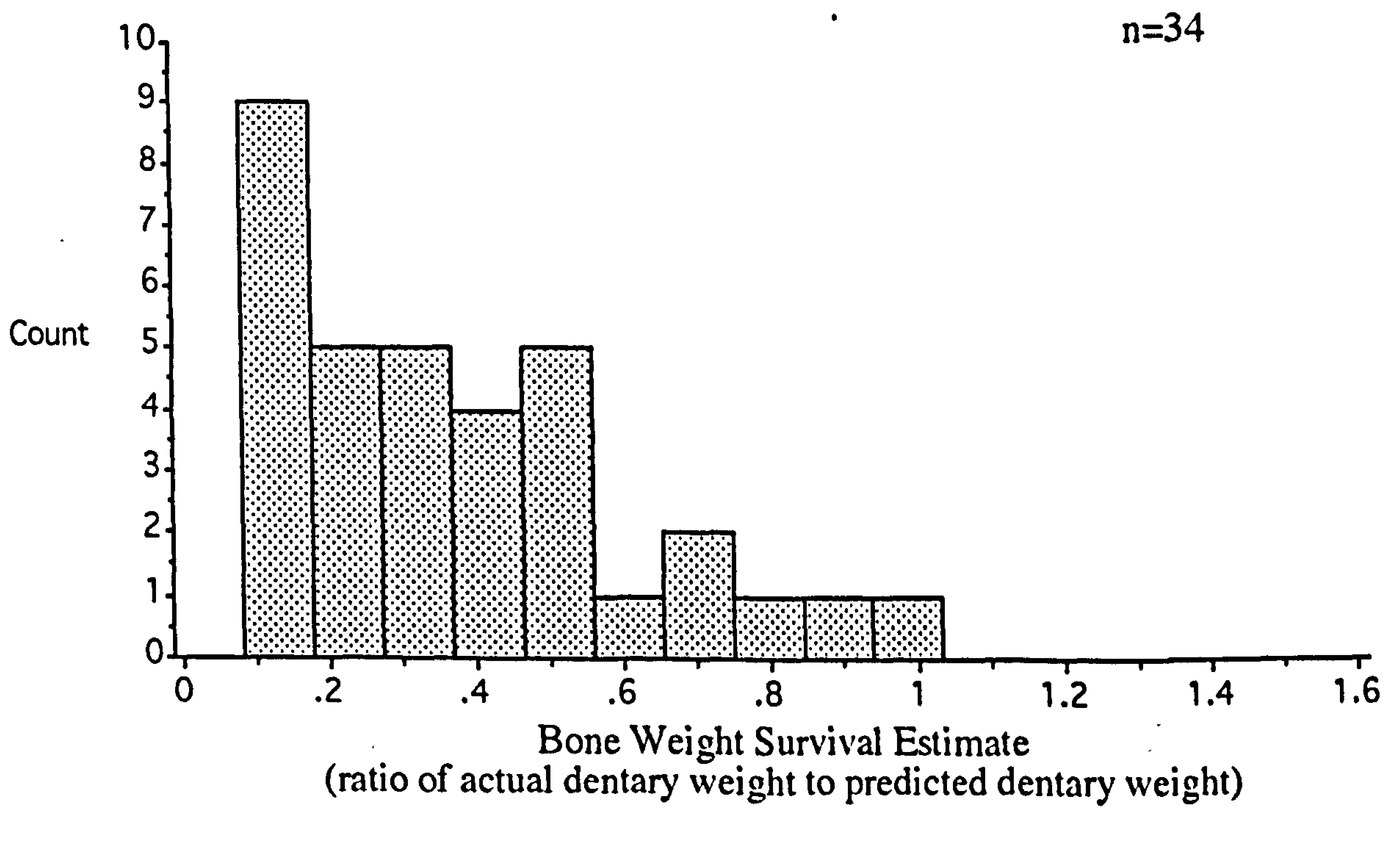


Figure 7.26. Earl's Bu, distribution of Bone Weight Survival Estimates for dentaries.

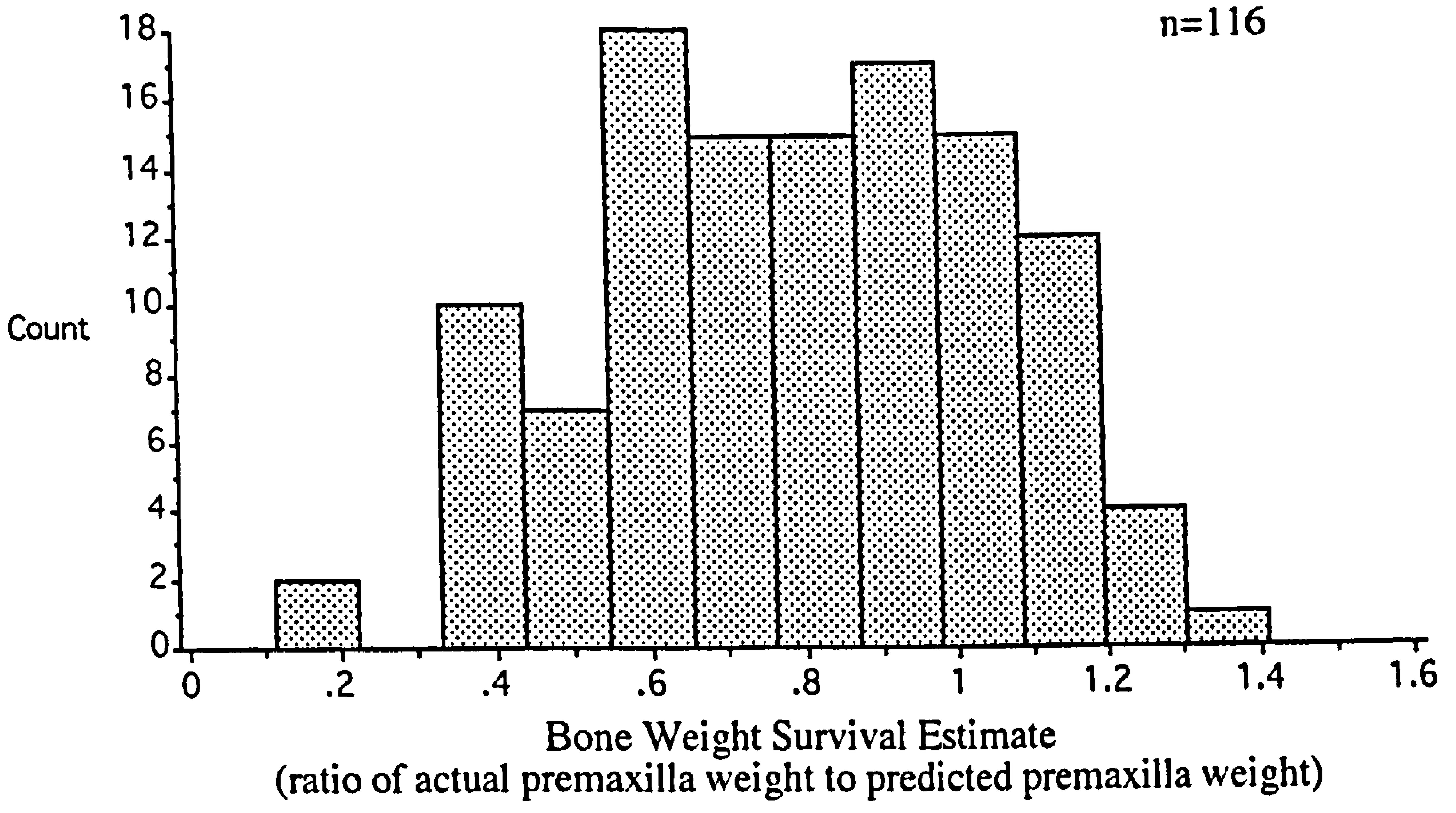


Figure 7.27. Robert's Haven, Area A, distribution of Bone Weight Survival Estimates for premaxillae.

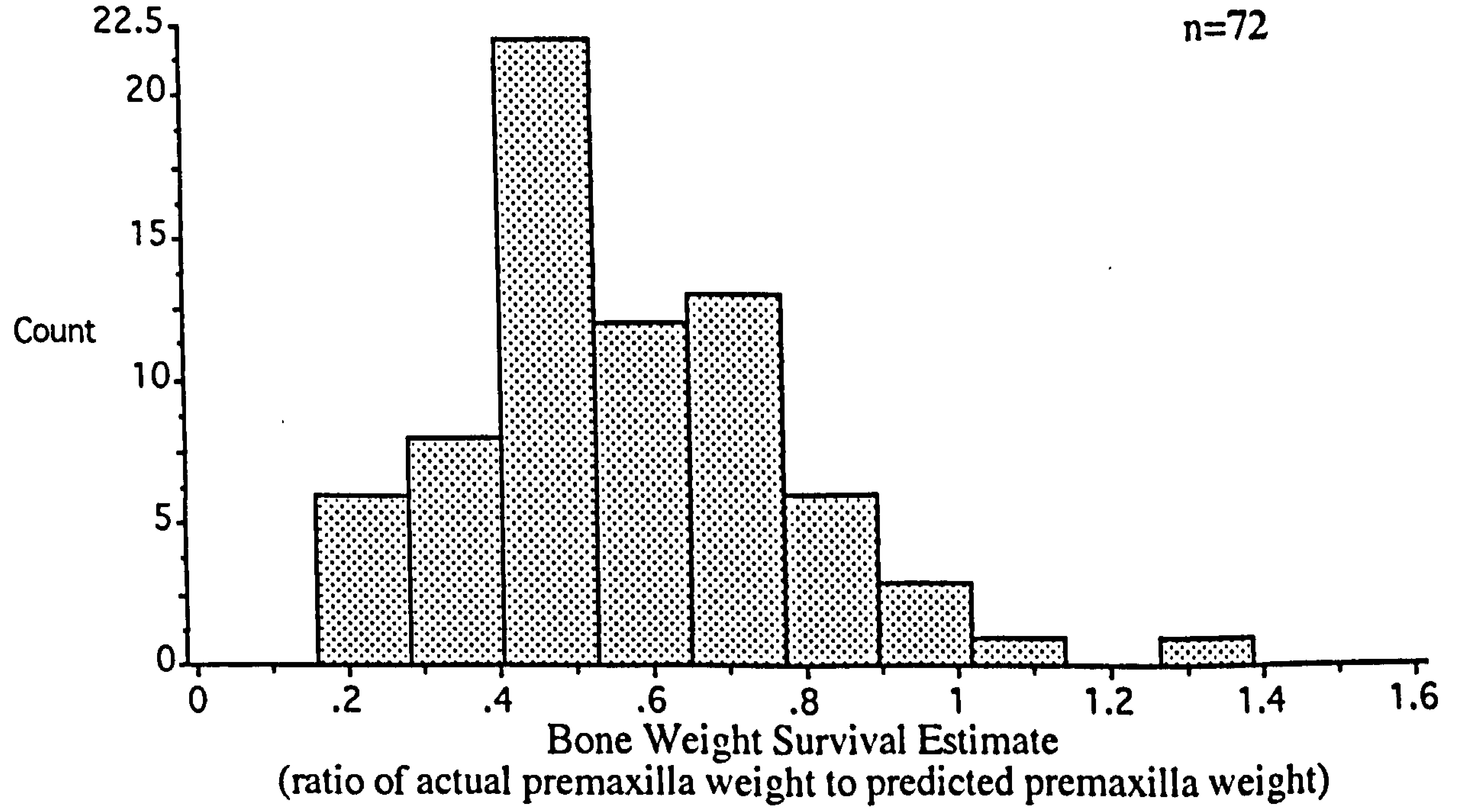


Figure 7.28. Earl's Bu, distribution of Bone Weight Survival Estimates for premaxillae.

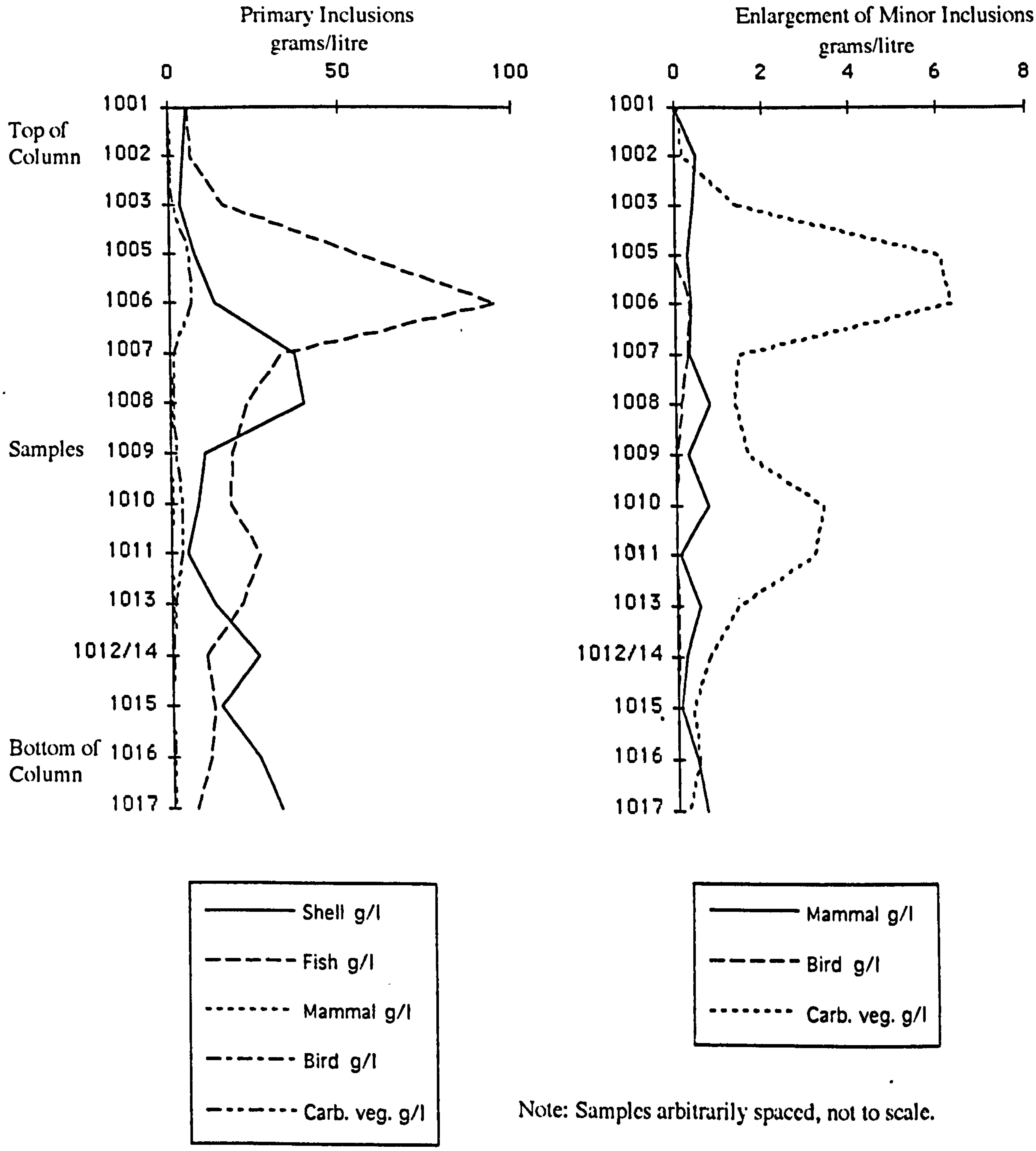


Figure 7.29. Robert's Haven Area A, Column A, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

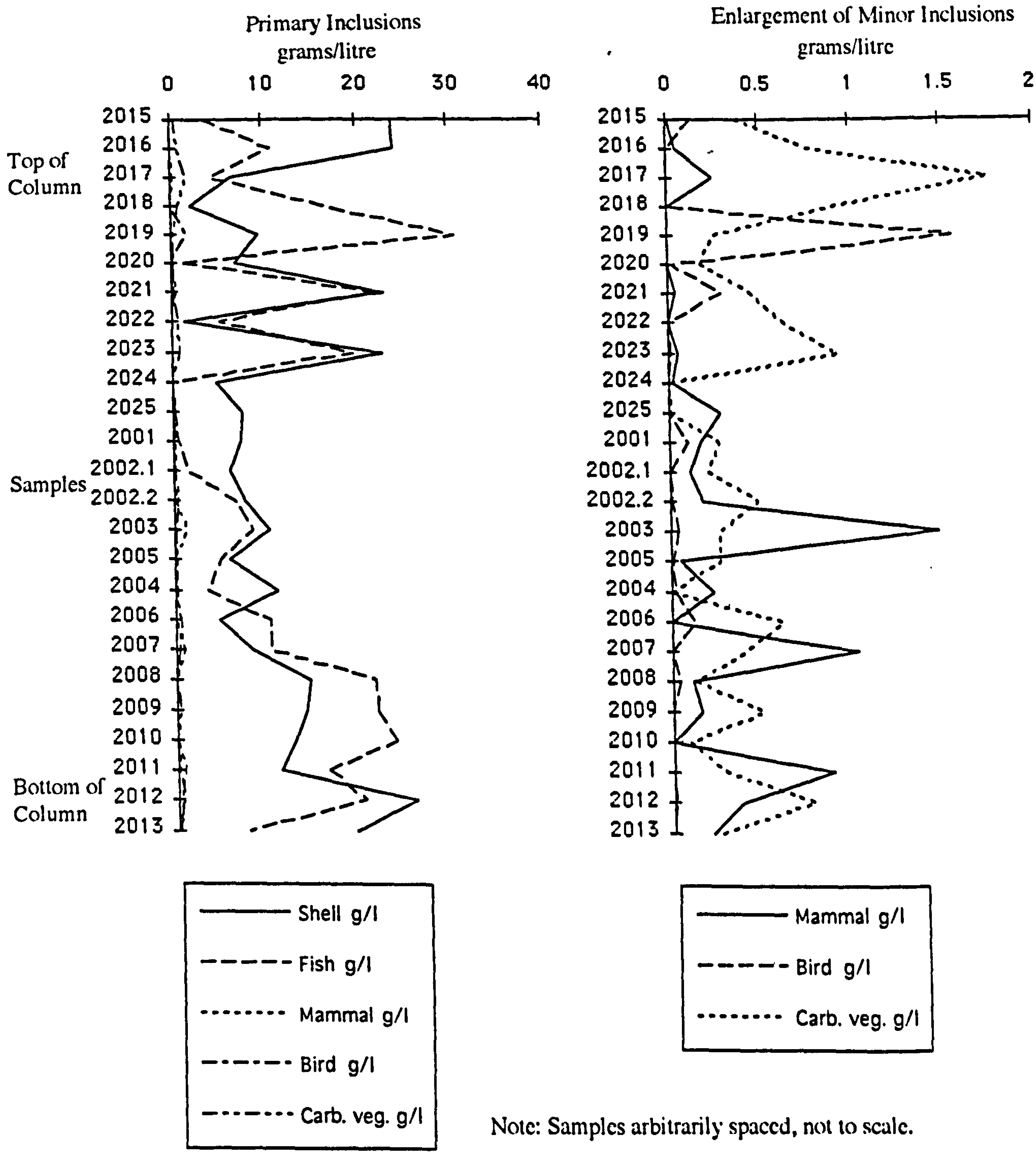
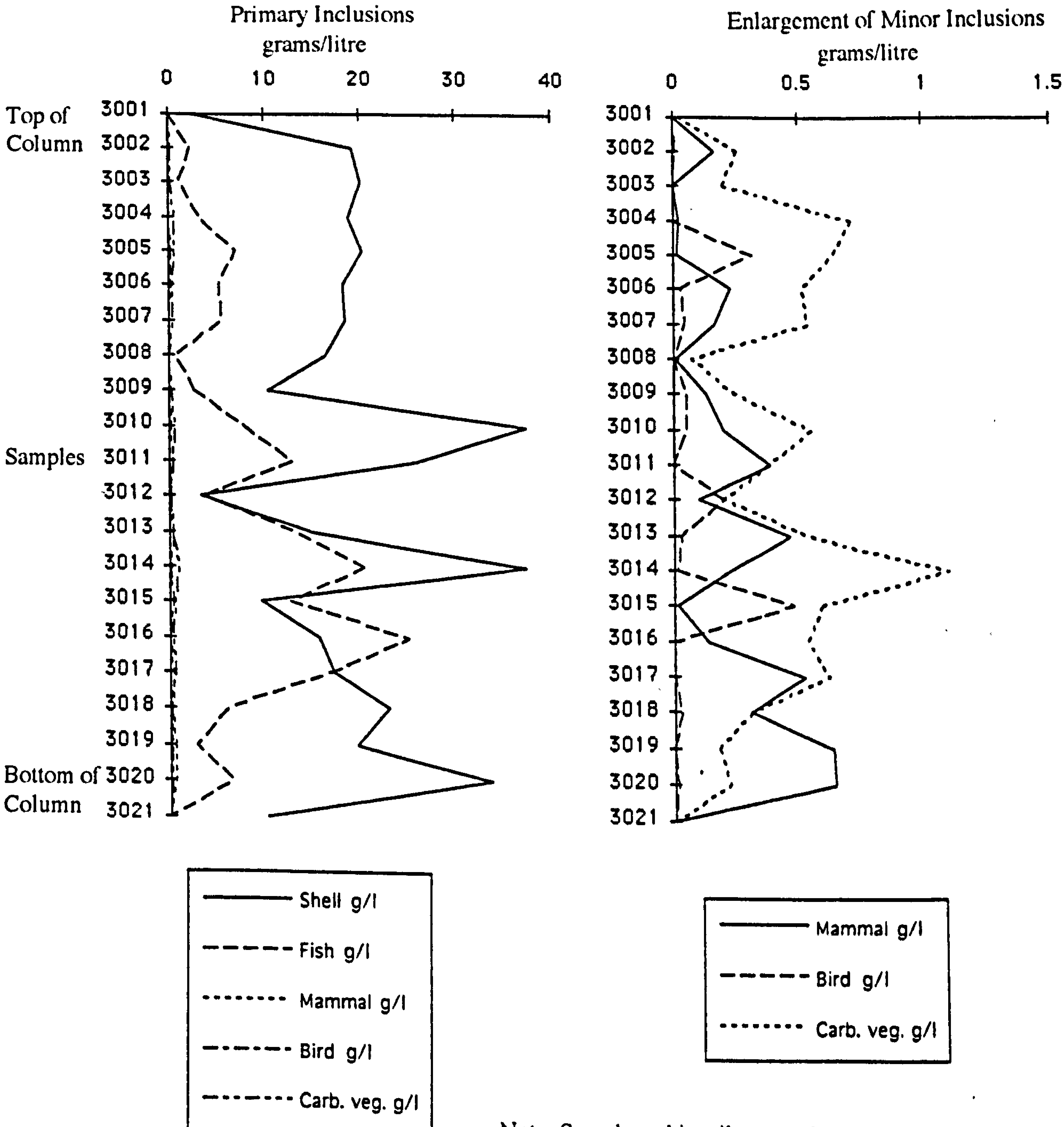


Figure 7.30. Robert's Haven Area A, Column B, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).



Note: Samples arbitrarily spaced, not to scale.

Figure 7.31. Robert's Haven Area A, Column C, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

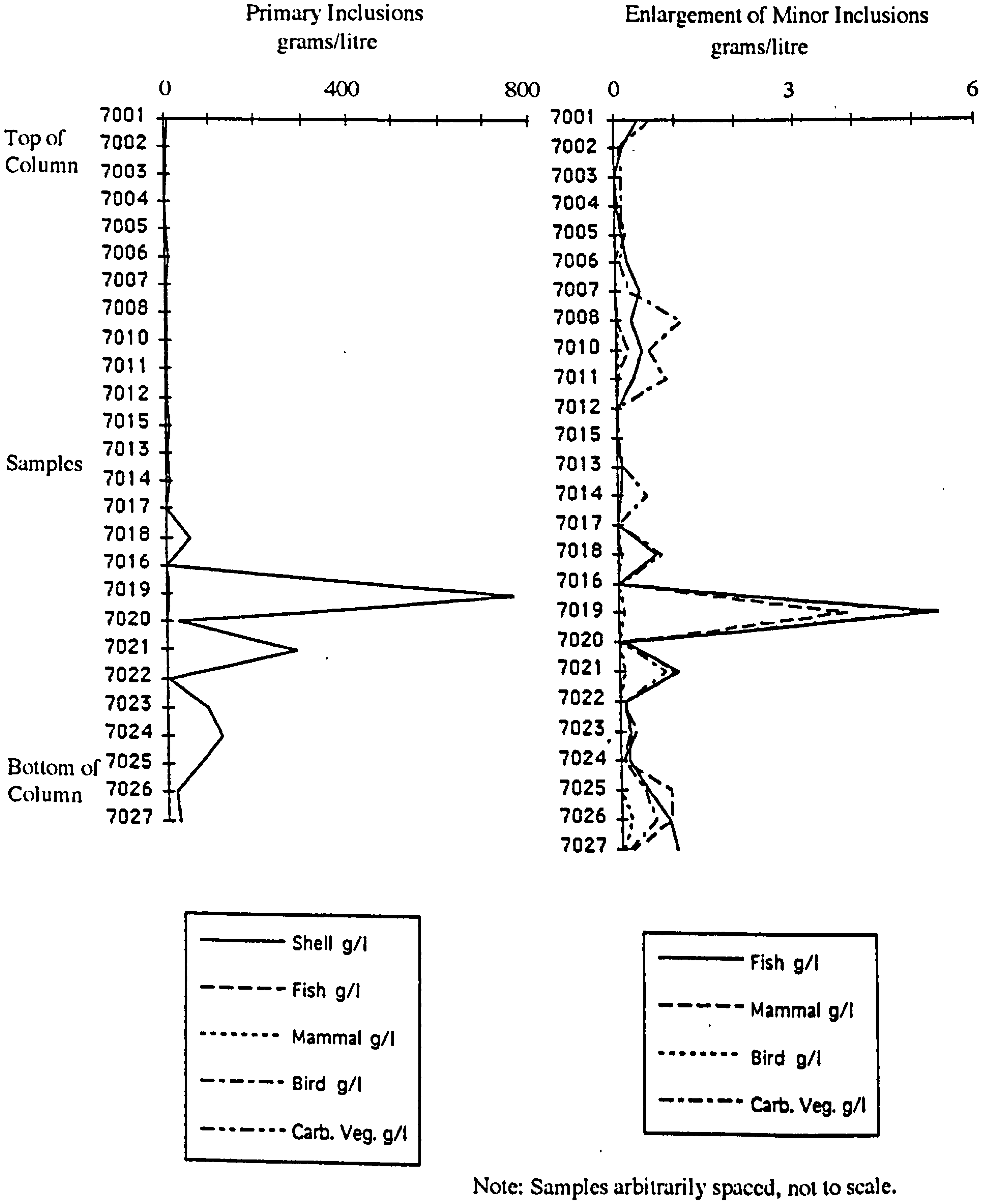


Figure 7.32. Robert's Haven Area B, Column G, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

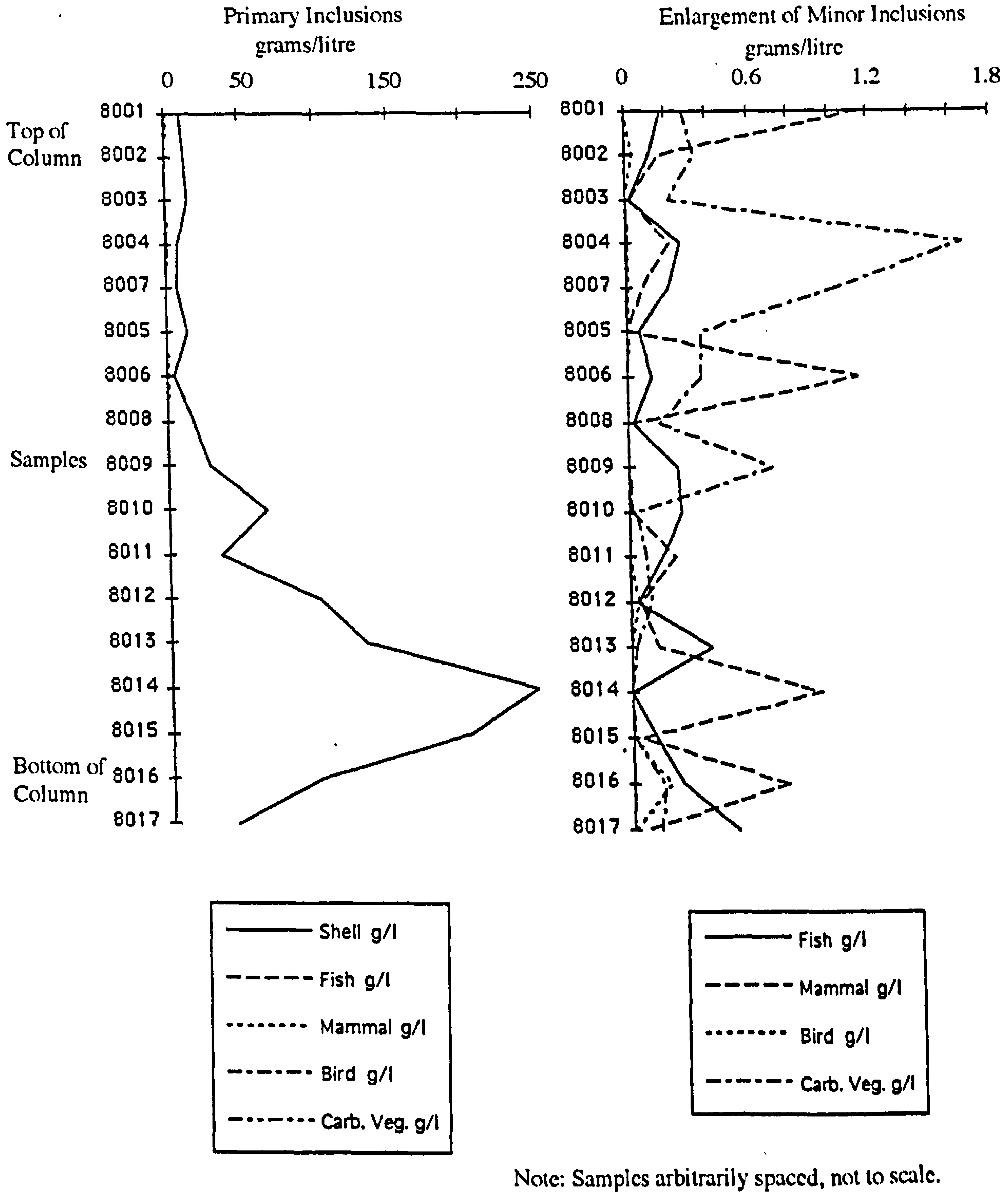


Figure 7.33. Robert's Haven Area B, Column H, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

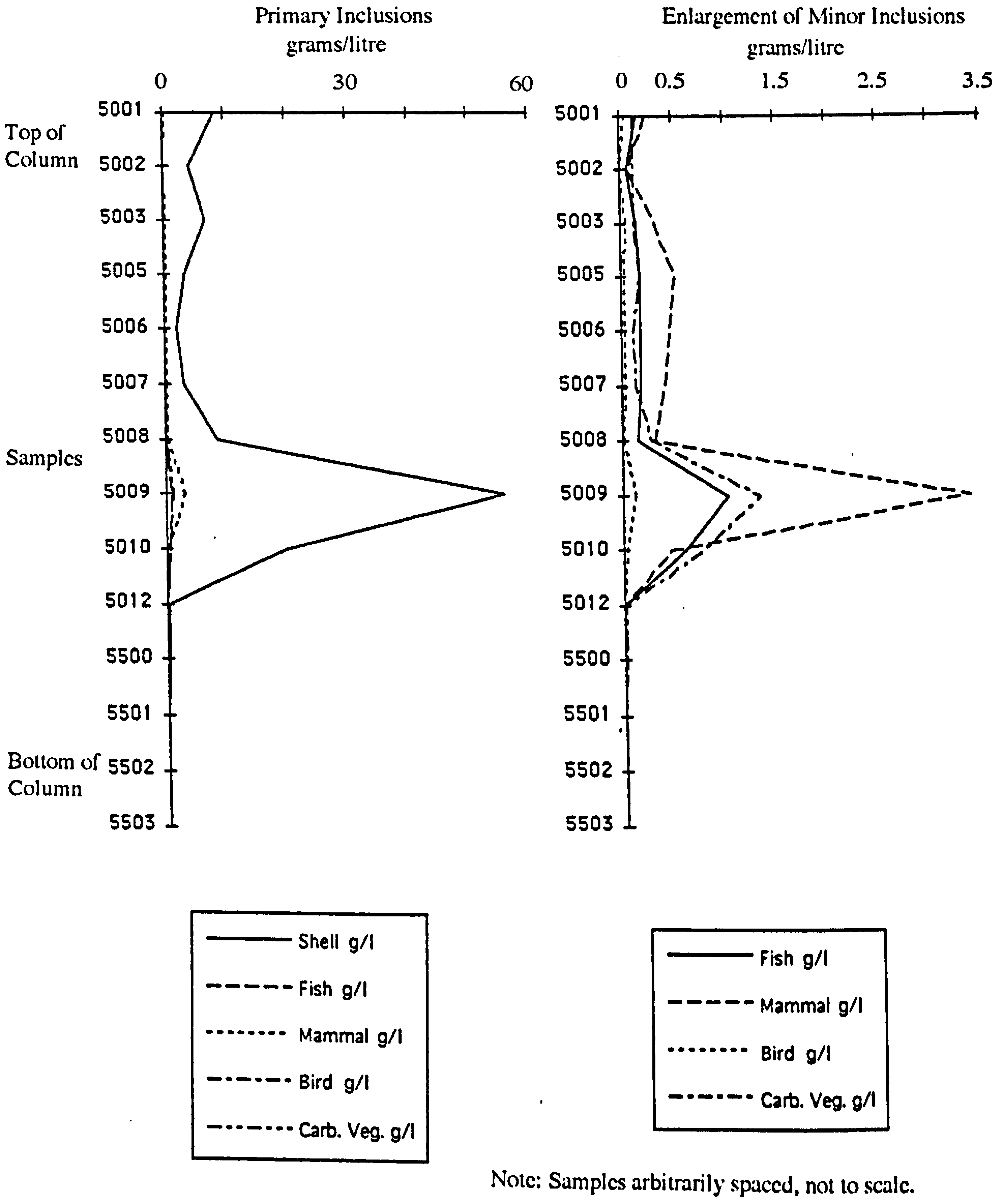


Figure 7.34. Robert's Haven Area E, Column E, density of quantified cultural inclusions (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

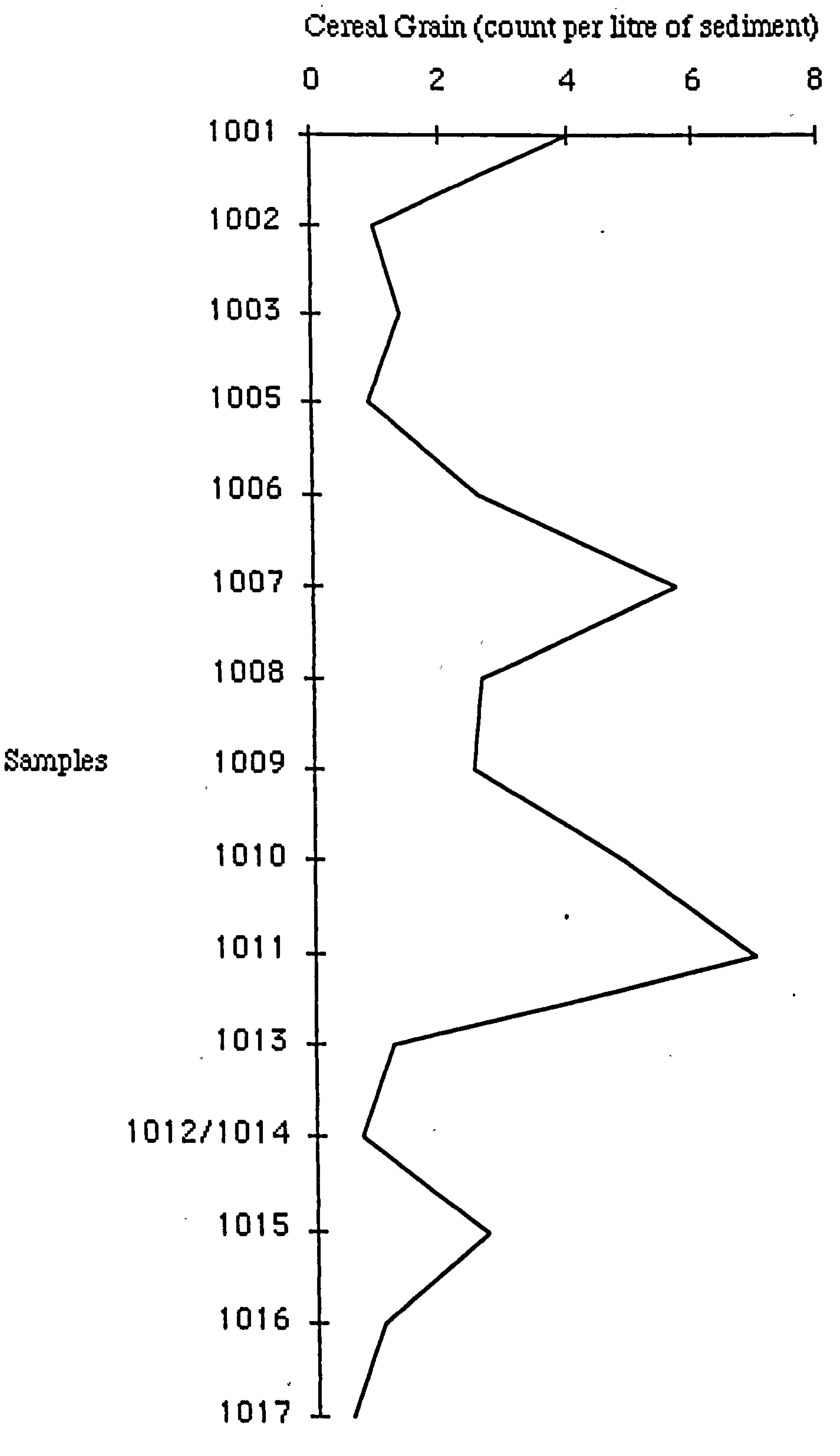


Figure 7.35. Robert's Haven Area A, Column A, density of cereal grain (See Appendix 7.I for a concordance of sample and context numbers from Robert's Haven).

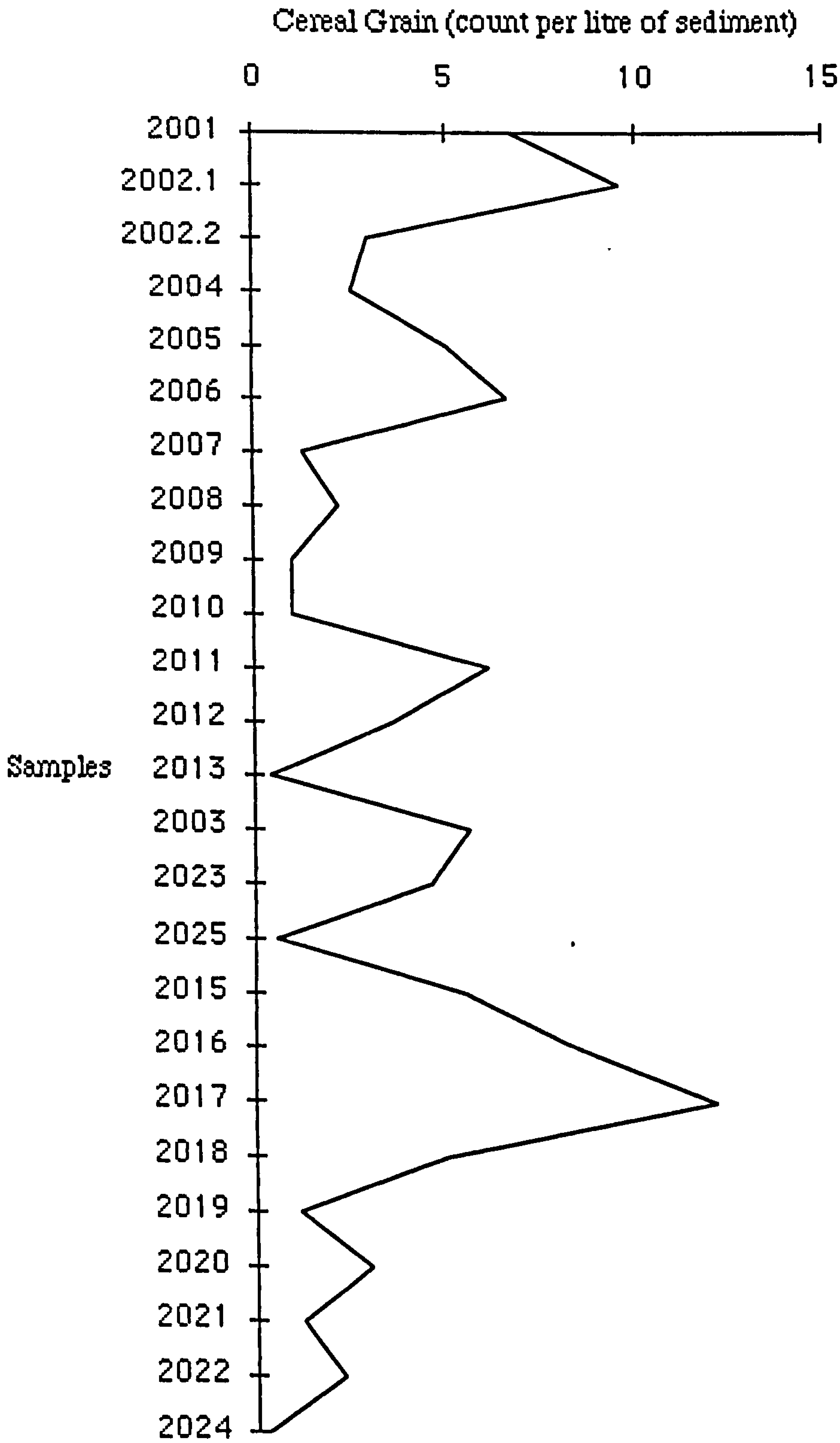


Figure 7.36. Robert's Haven Area A, Column B, density of cereal grain (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

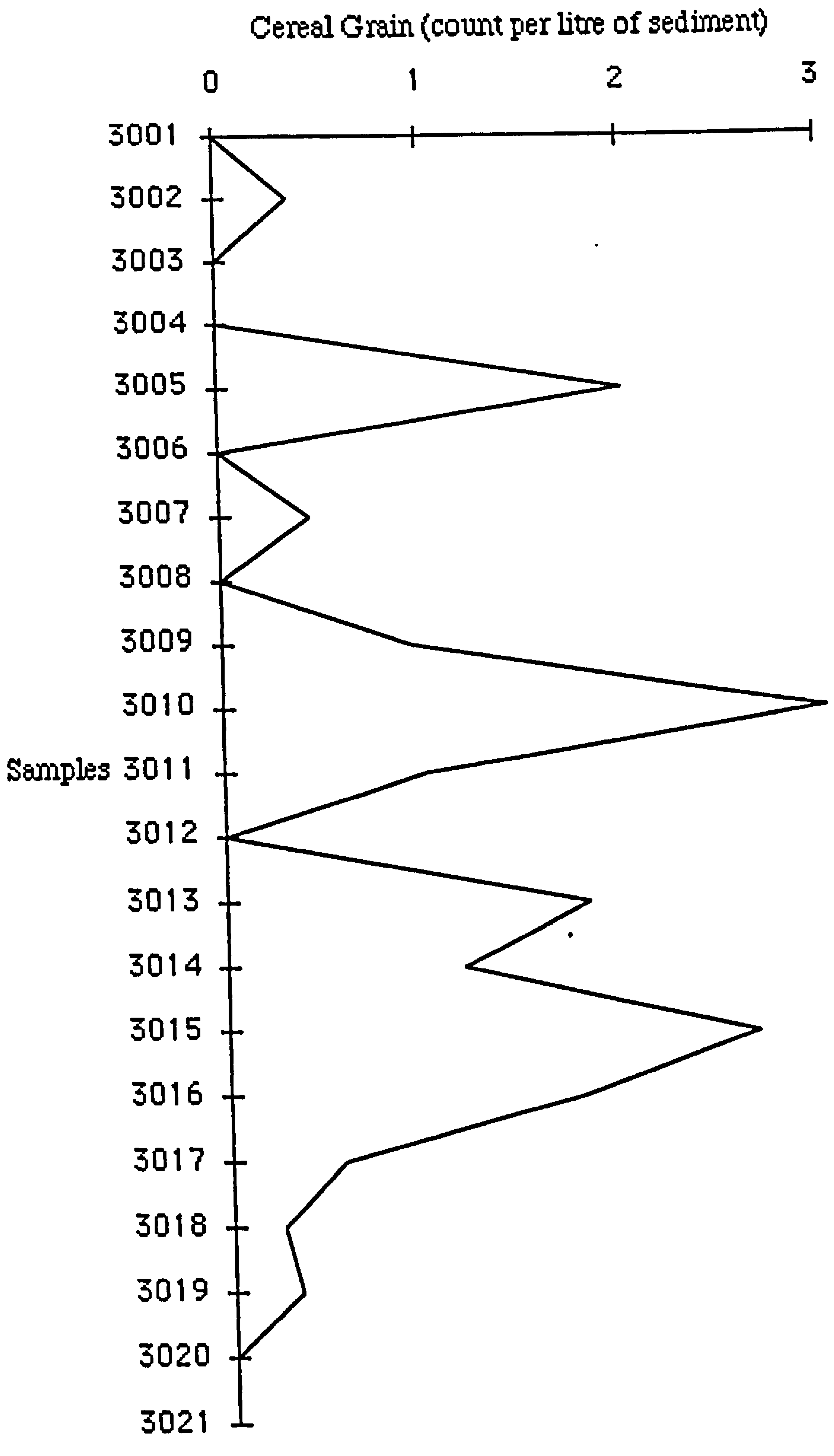


Figure 7.37. Robert's Haven Area A, Column C, density of cereal grain (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

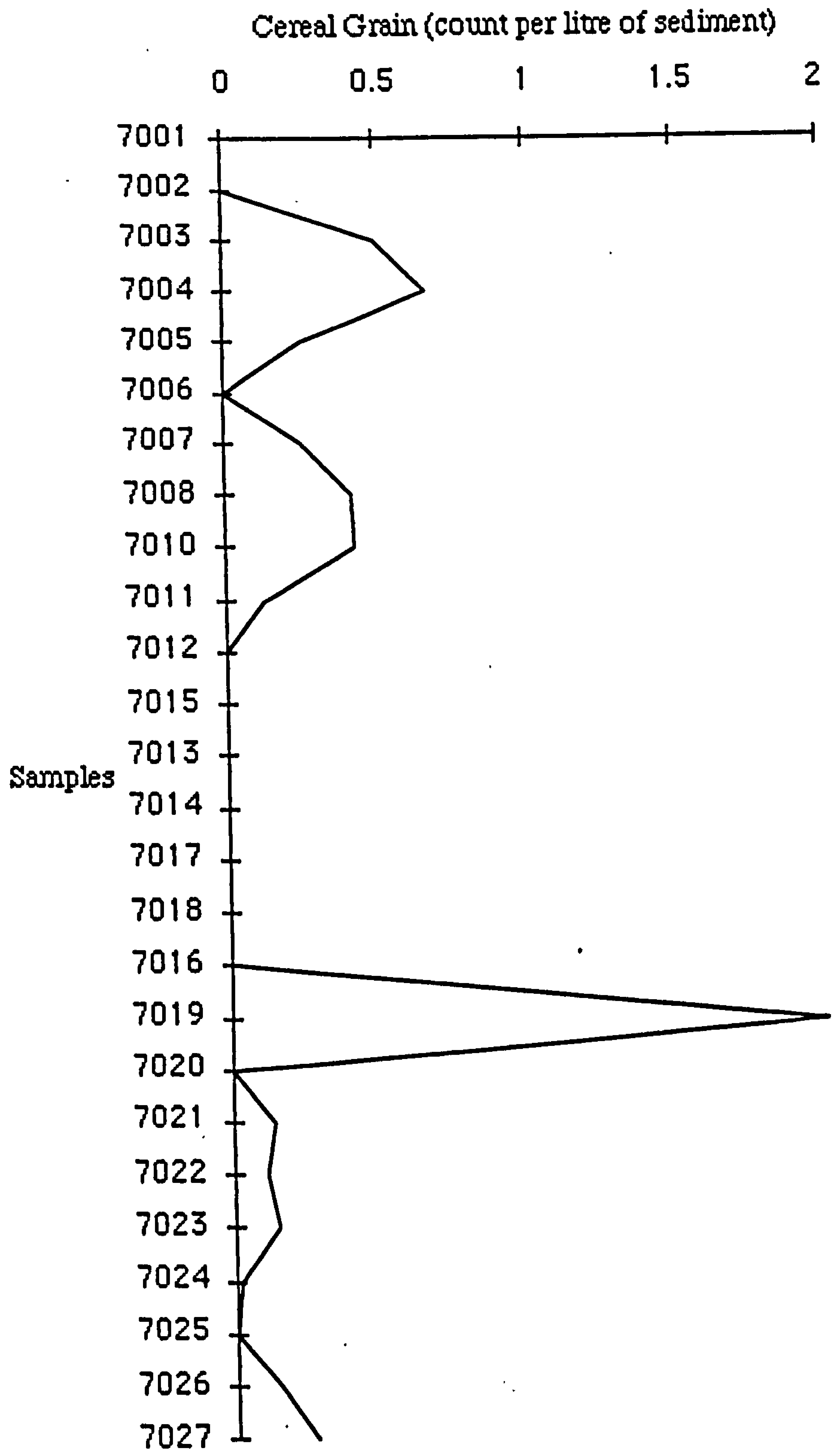


Figure 7.38. Robert's Haven Area B, Column G, density of cereal grain (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).

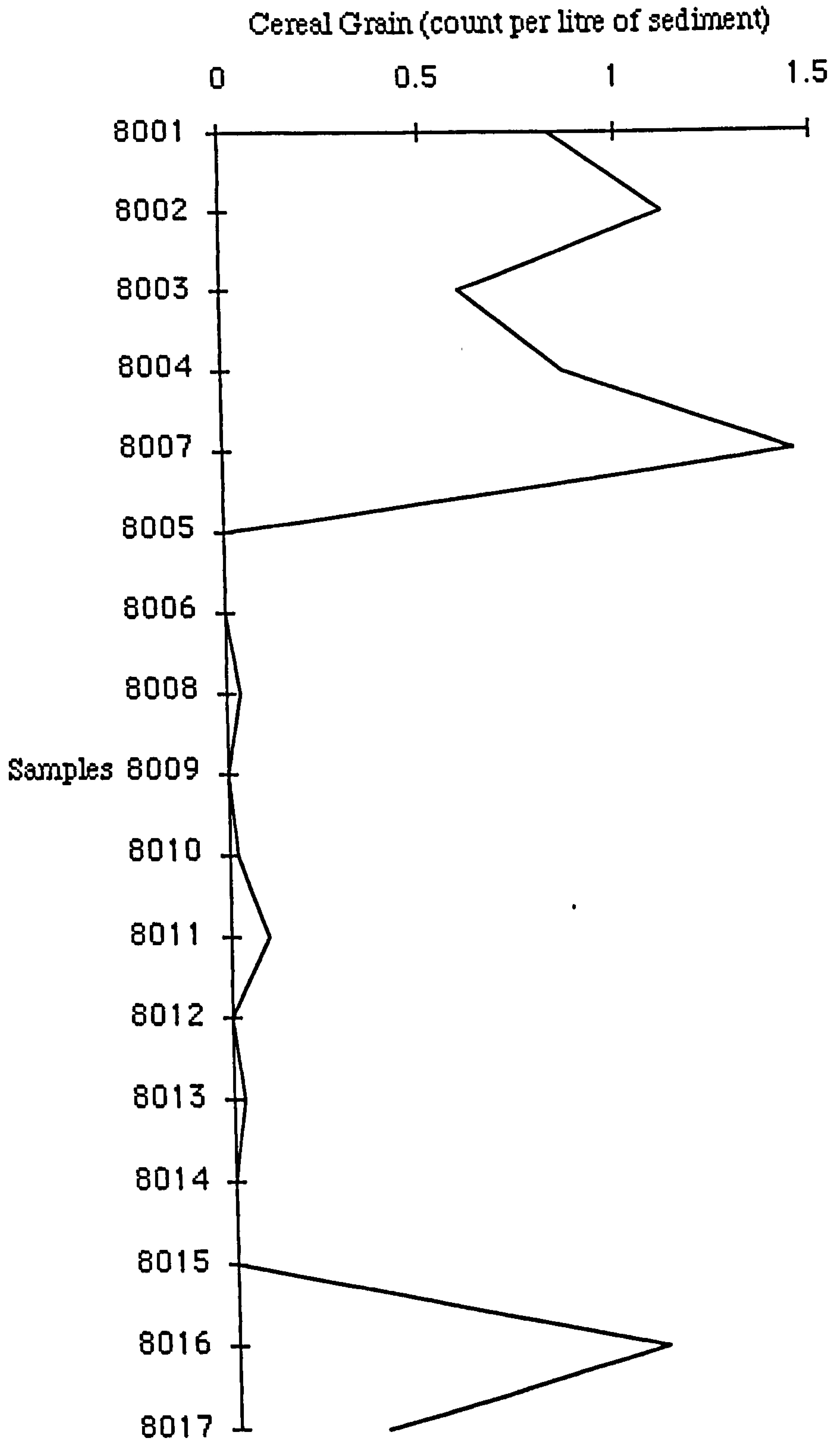
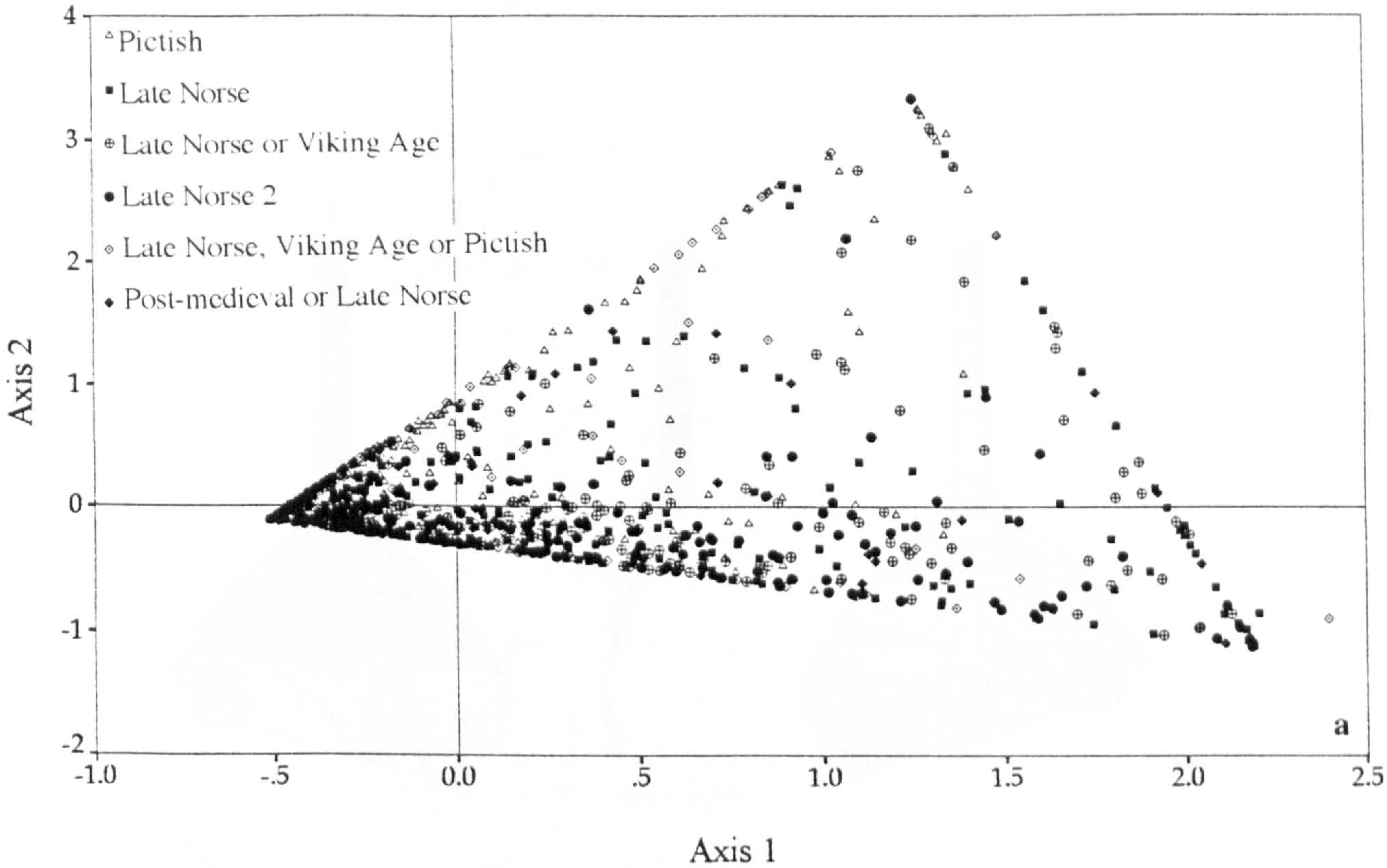


Figure 7.39. Robert's Haven Area B, Column H, density of cereal grain (See Appendix 7.1 for a concordance of sample and context numbers from Robert's Haven).



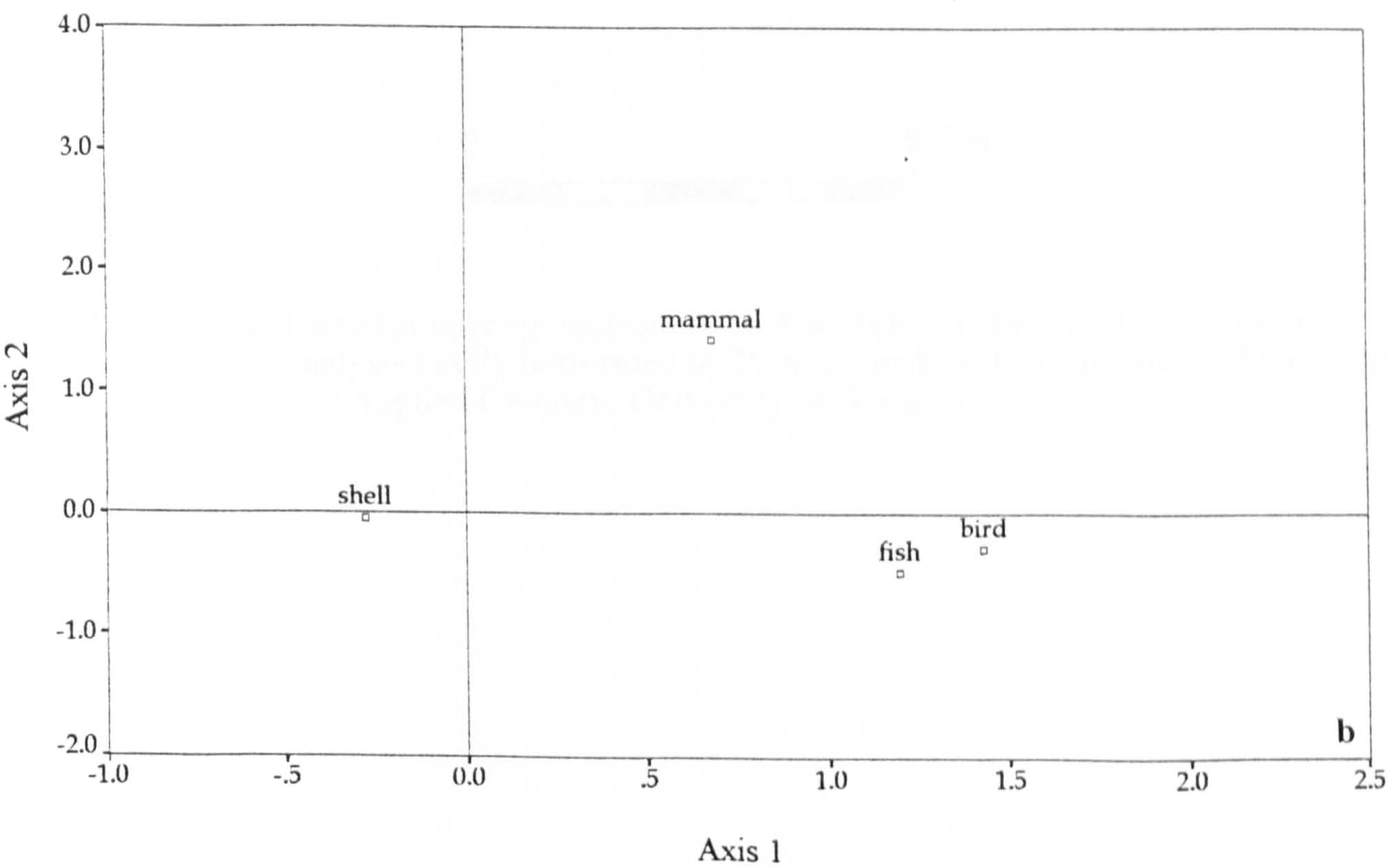


Figure 7.40. Axes 1 and 2 of a correspondence analysis of the weight of shell, fish bone, mammal bone and bird bone (sorted using the methods of Jones et al. forthcoming a) in 1016 samples from Freswick Links. Samples from hiatus strata have been omitted. Diagram a is the row plot for each sample (labeled by period) while diagram b is the column plot for each material. Explanation on axes 1 and 2 is 59.1% and 35.7% respectively. Axis 1 has been stretched for ease of interpretation.

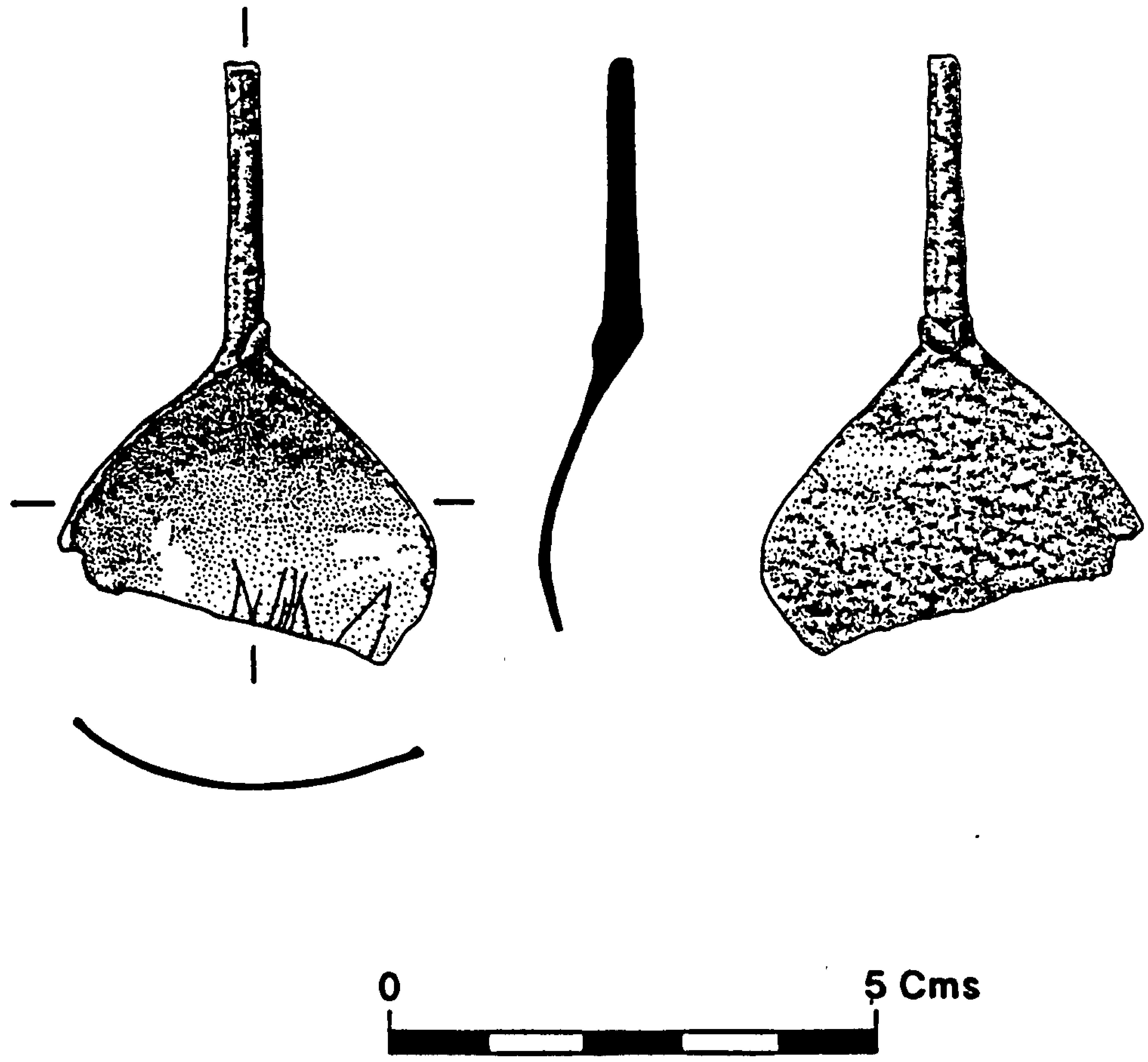
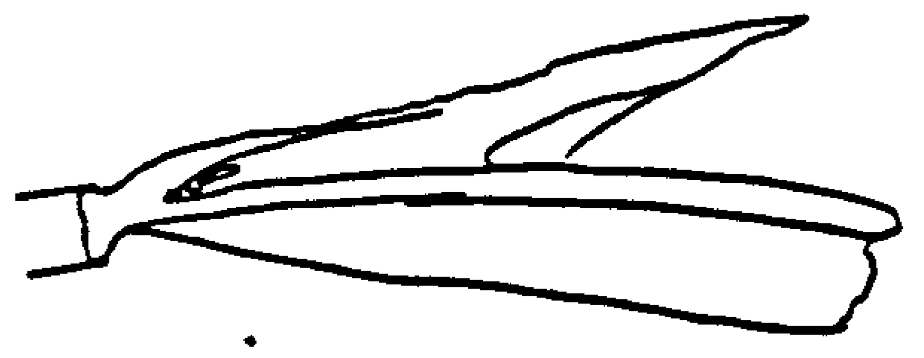


Figure 7.41. Tinned copper spoon from Area A at Robert's Haven (SEM microprobe analysis kindly performed by P. Ainsworth of the Department of Geology and Applied Geology, University of Glasgow).

Lateral View of Left Gadoid Dentary

Dentary Measurement 1 (D1)



Dentary Measurement 2 (D2)

Lateral View of Left Gadoid Premaxillae

Premaxilla Measurement 1 (P1)

Ventral View of Left Gadoid Premaxilla

Premaxilla Measurement 2 (P2)

Figure 8.1. Guide to measurements taken on gadoid bones for estimation of fish total length and bone weight survival (based on Jones 1991a:58).

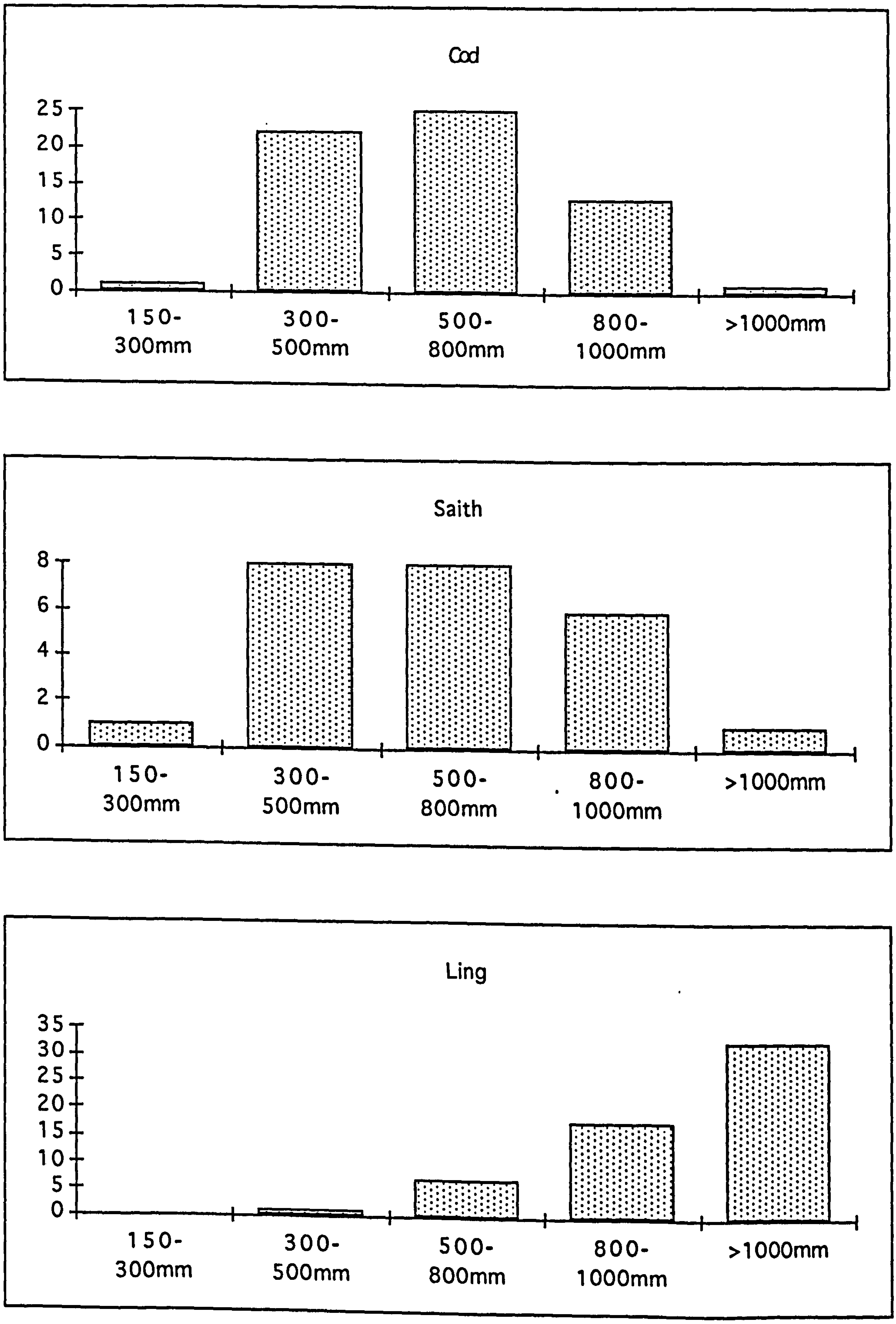
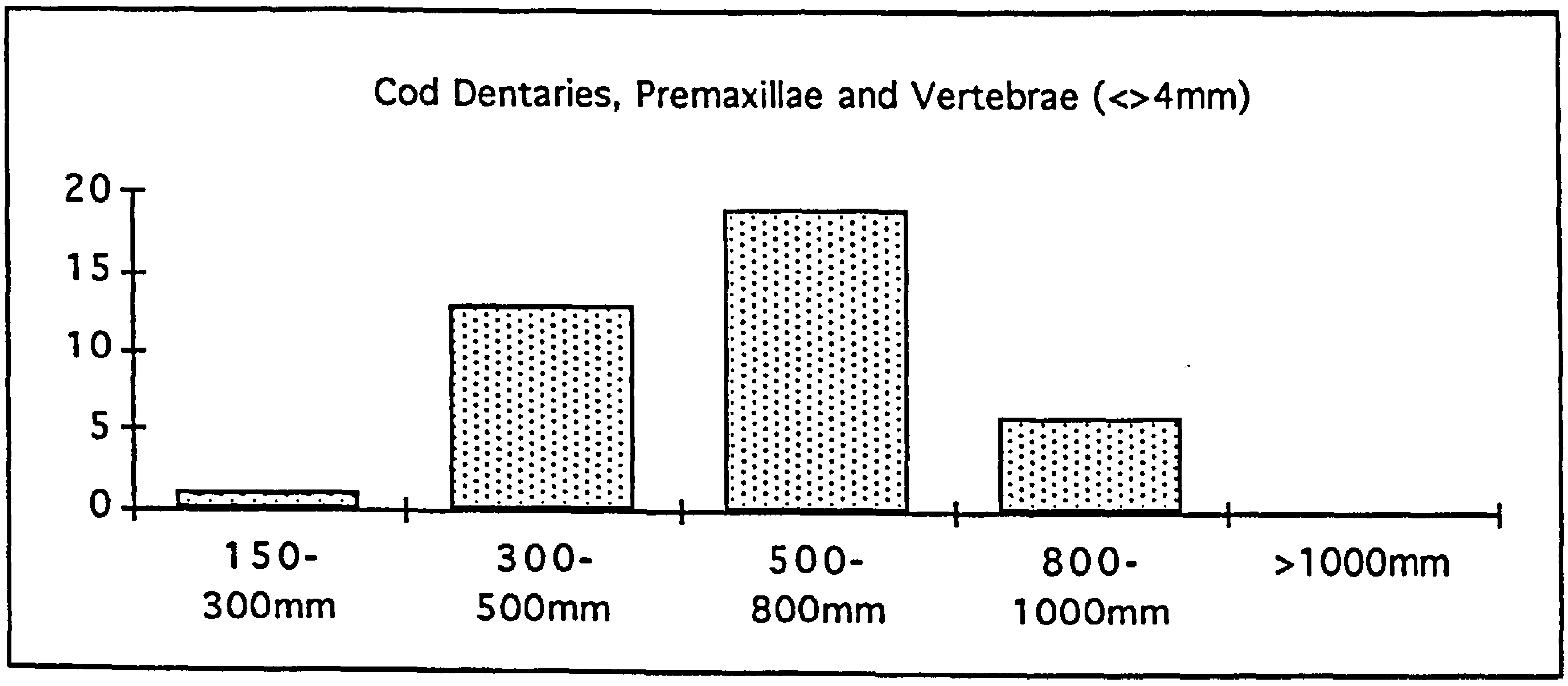
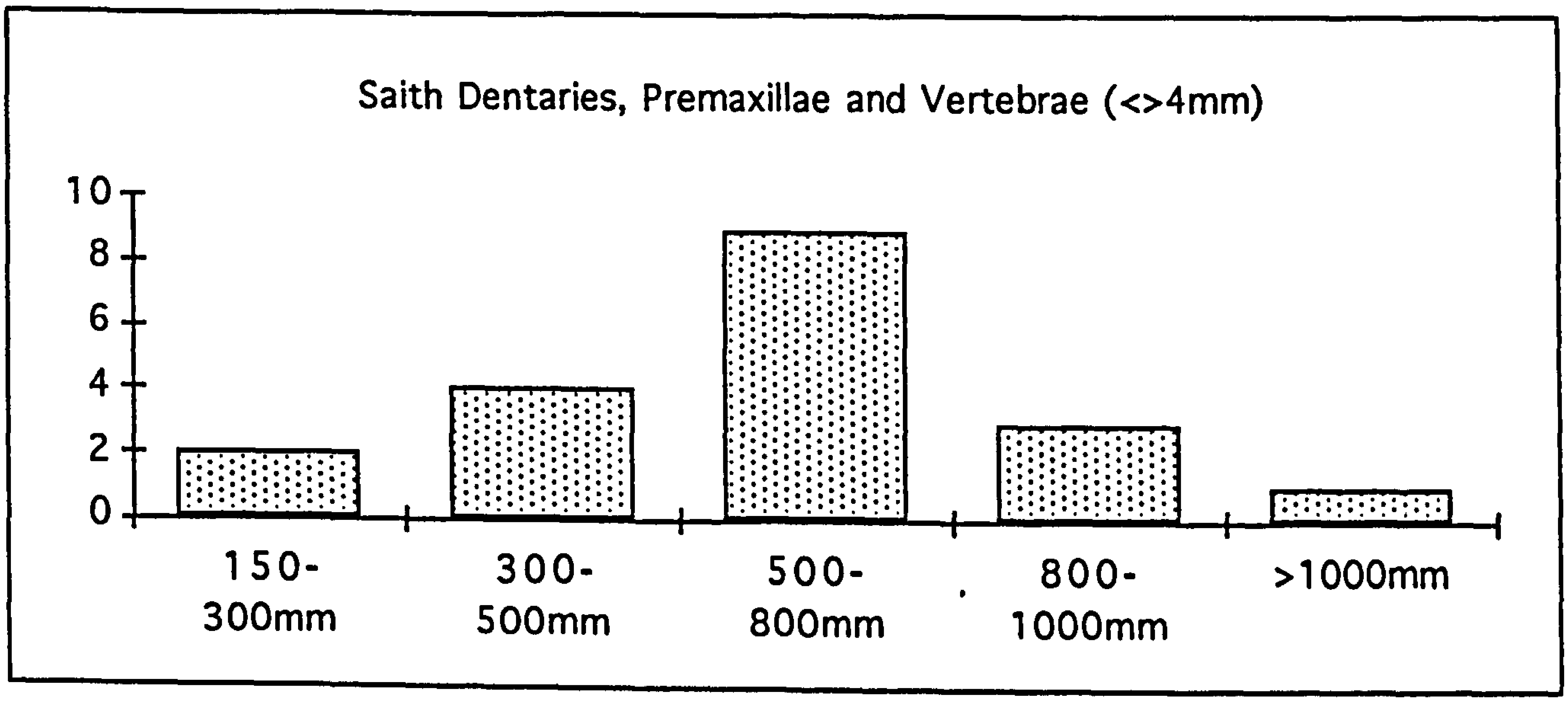


Figure 8.2. Robert's Haven Area A, estimated total length distributions based on fire altered cod, saith and ling specimens (>4mm sample fraction).





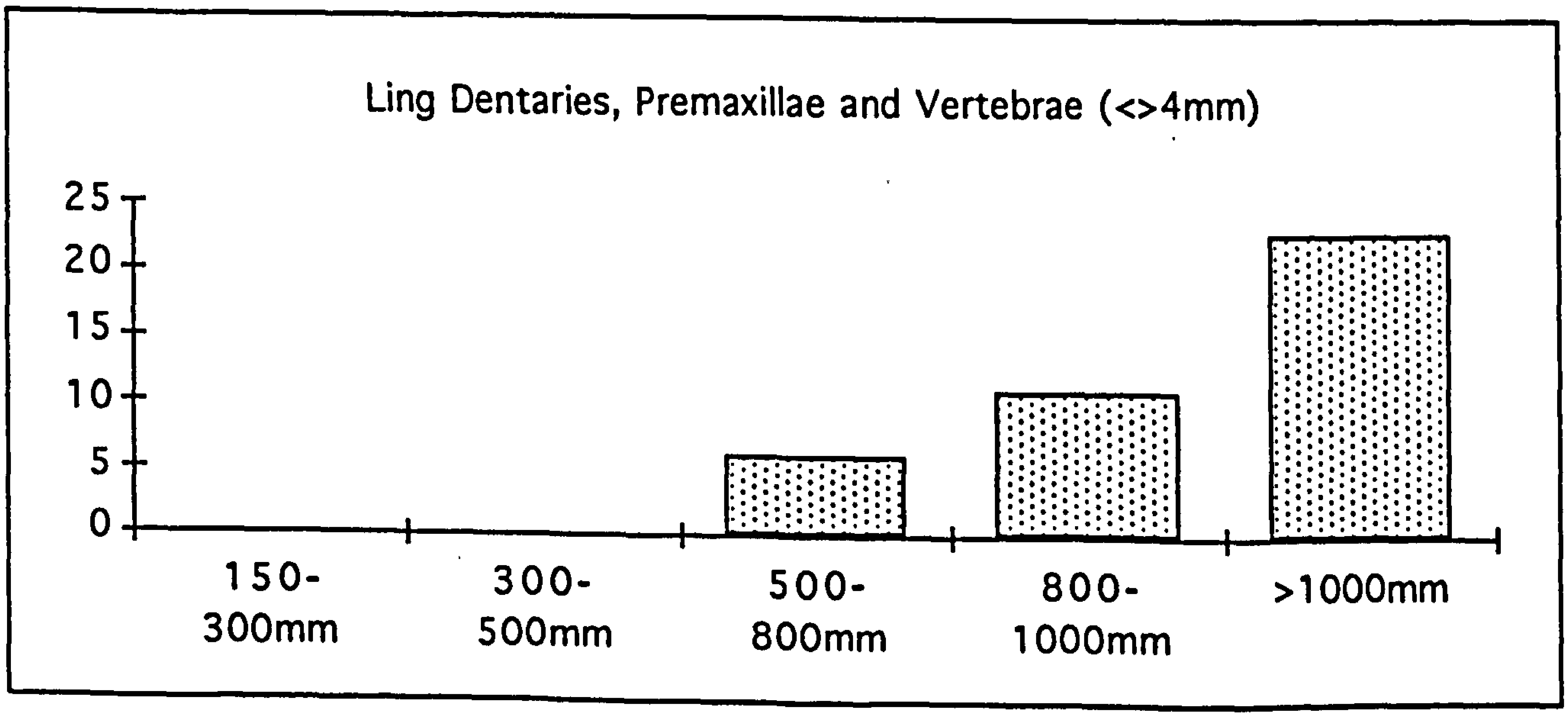
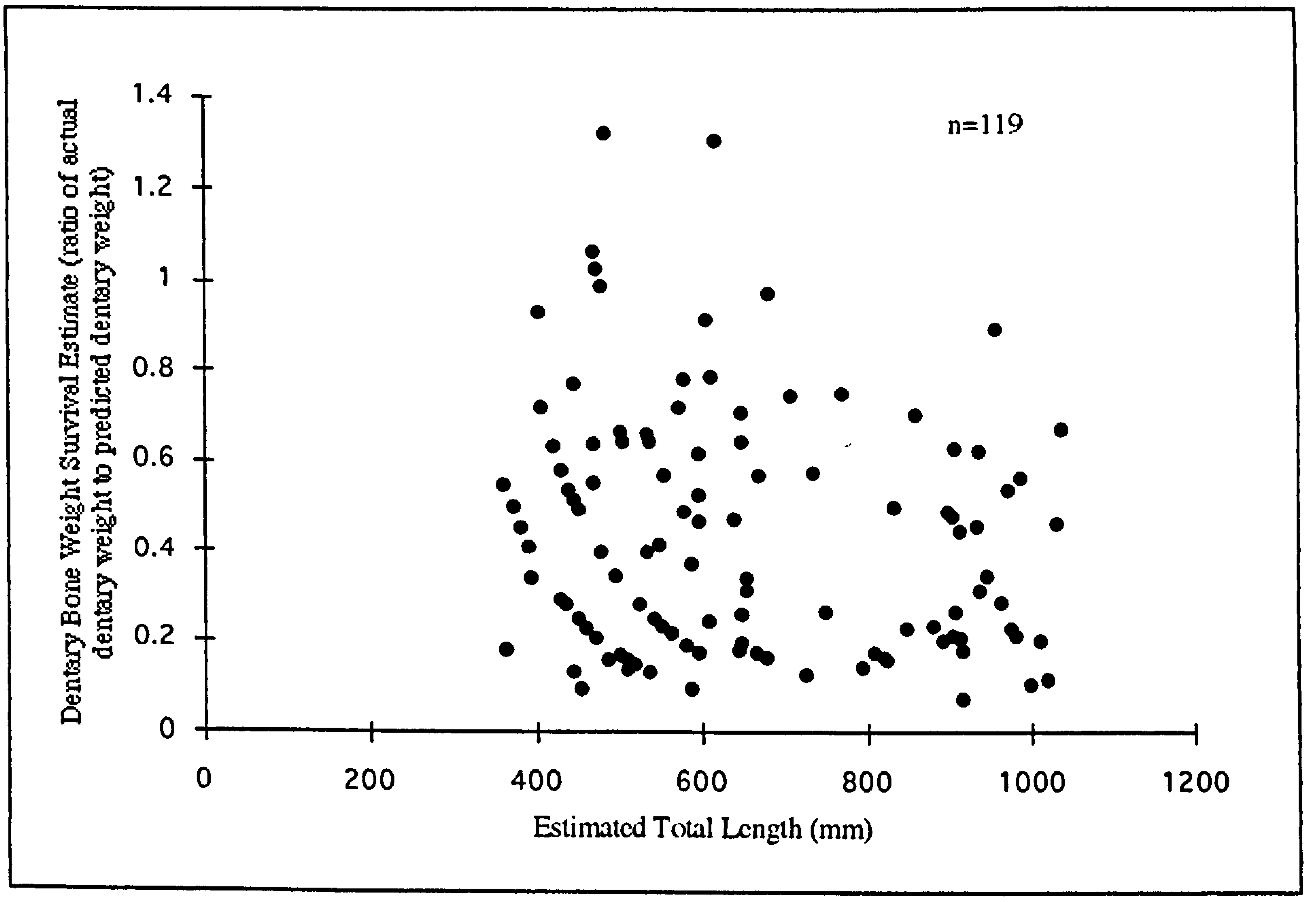


Figure 8.3. Robert's Haven Area A, estimated total length distributions based on fire altered cod, saith and ling specimens (for elements sorted from both >4mm and <4mm sample fractions).



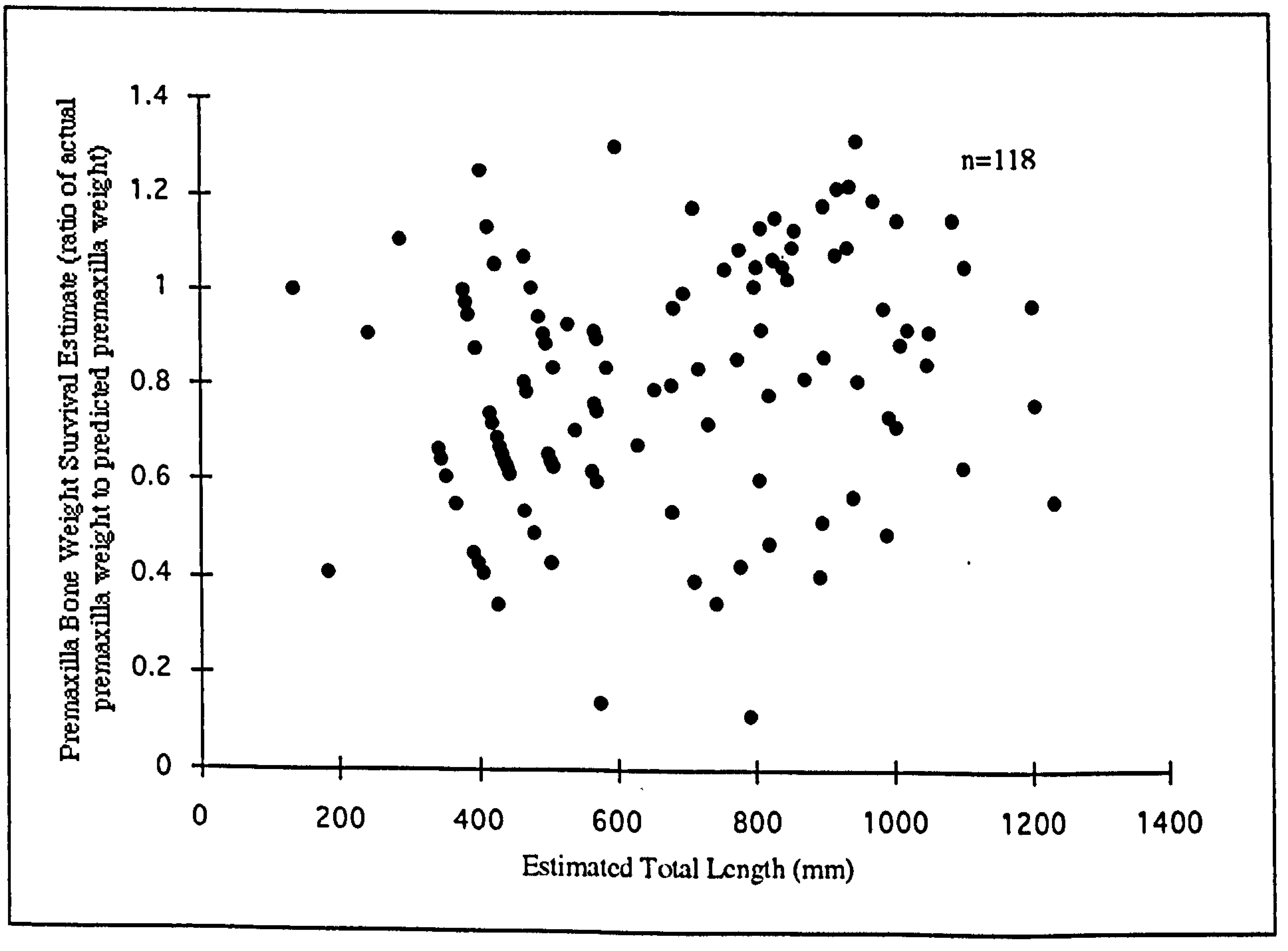


Figure 8.4. Robert's Haven Area A, relationship between fish size and bone preservation based on cod dentaries and premaxillae.

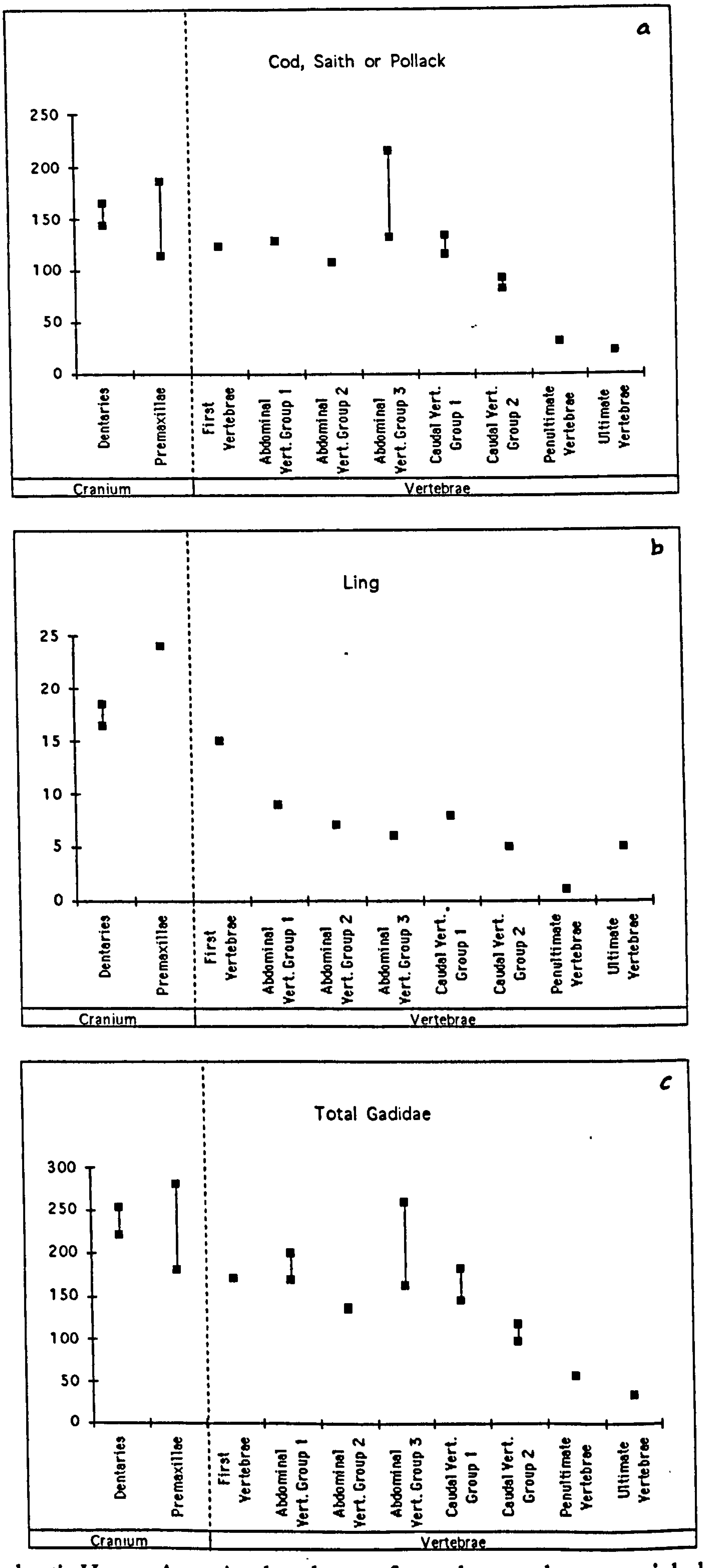


Figure 8.5. Robert's Haven Area A, abundance of vertebrae and two cranial elements (sorted from both >4mm and <4mm sample fractions) for the most common gadoid taxa. The fragment count for each group of vertebrae is divided by the number in a single fish. A range of values is sometimes caused by inter-specific variability in anatomy, or (for dentaries and premaxillae) the difference between right and left elements.

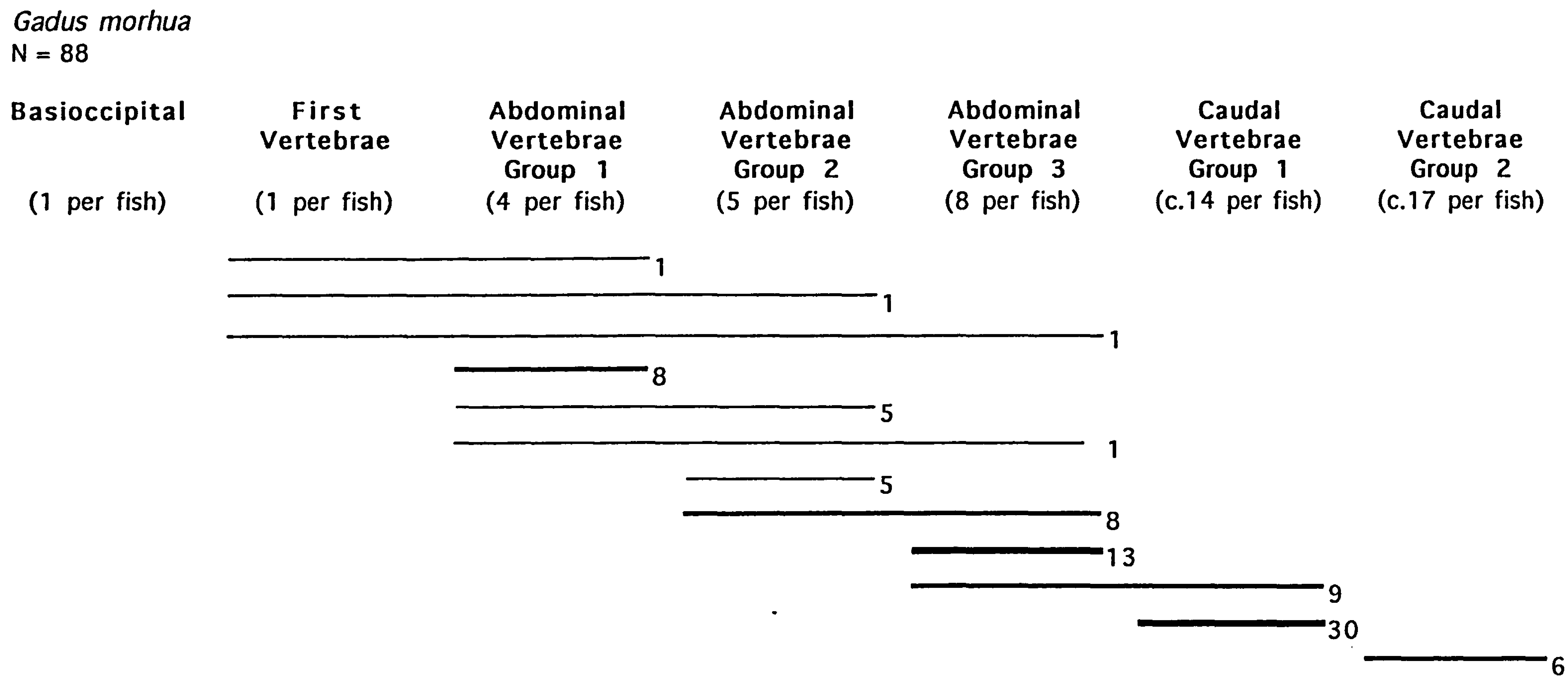


Figure 8.6. Robert's Haven Area A, groups of articulated cod vertebrae. The number of articulations which span particular regions of the vertebral column is indicated by both the thickness of the lines and the appended digits.

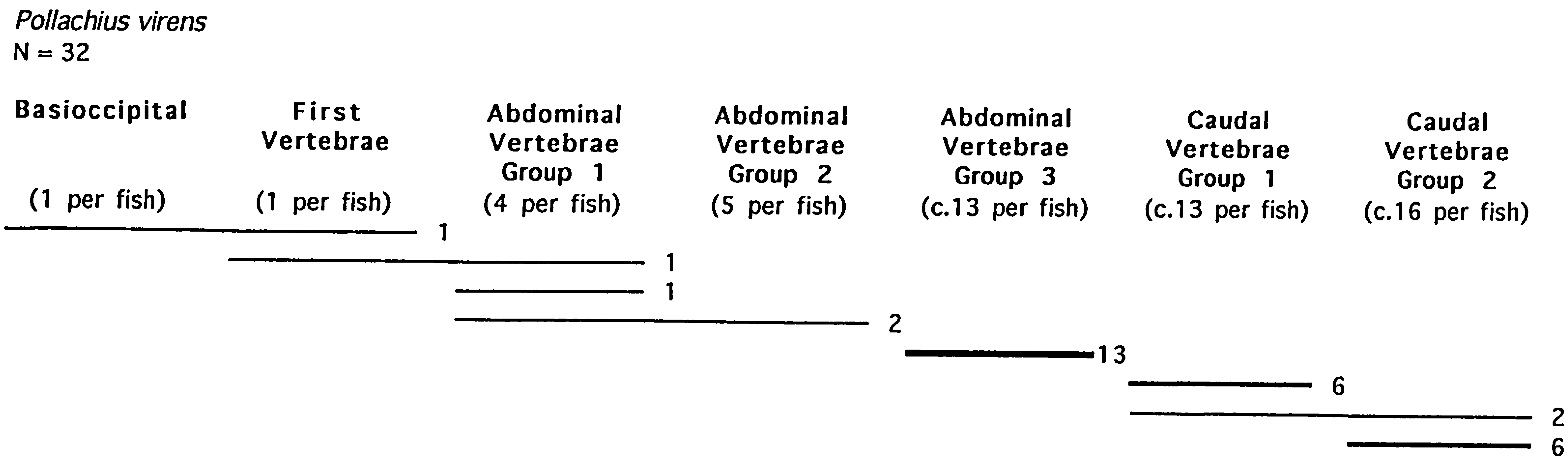


Figure 8.7. Robert's Haven Area A, groups of articulated saith vertebrae. The number of articulations which span particular regions of the vertebral column is indicated by both the thickness of the lines and the appended digits.

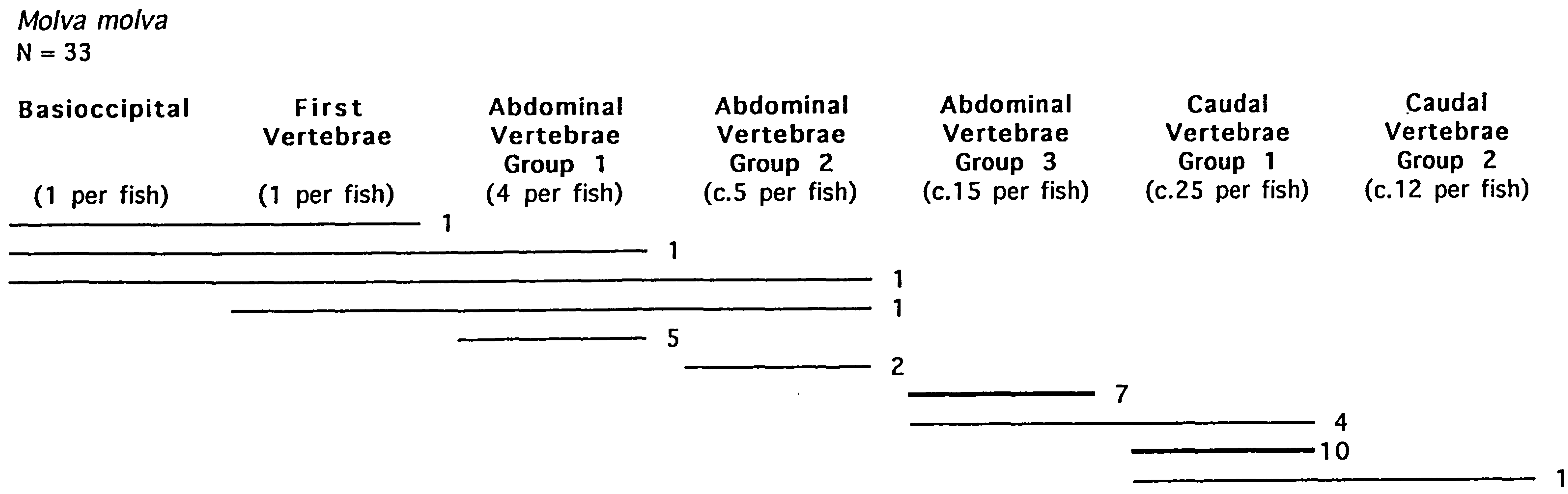


Figure 8.8. Robert's Haven Area A, groups of articulated ling vertebrae. The number of articulations which span particular regions of the vertebral column is indicated by both the thickness of the lines and the appended digits.

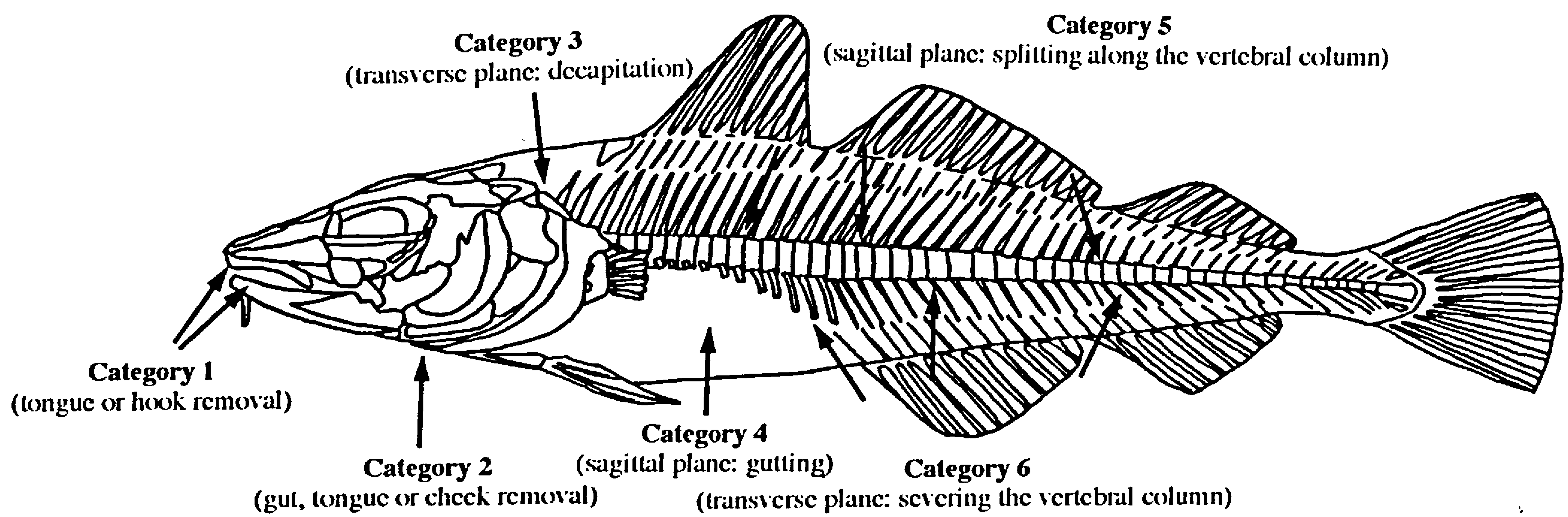


Figure 8.9. Robert's Haven Area A, locations of butchery on the gadoid skeleton (base drawing after Brinkhuizen 1994:199).

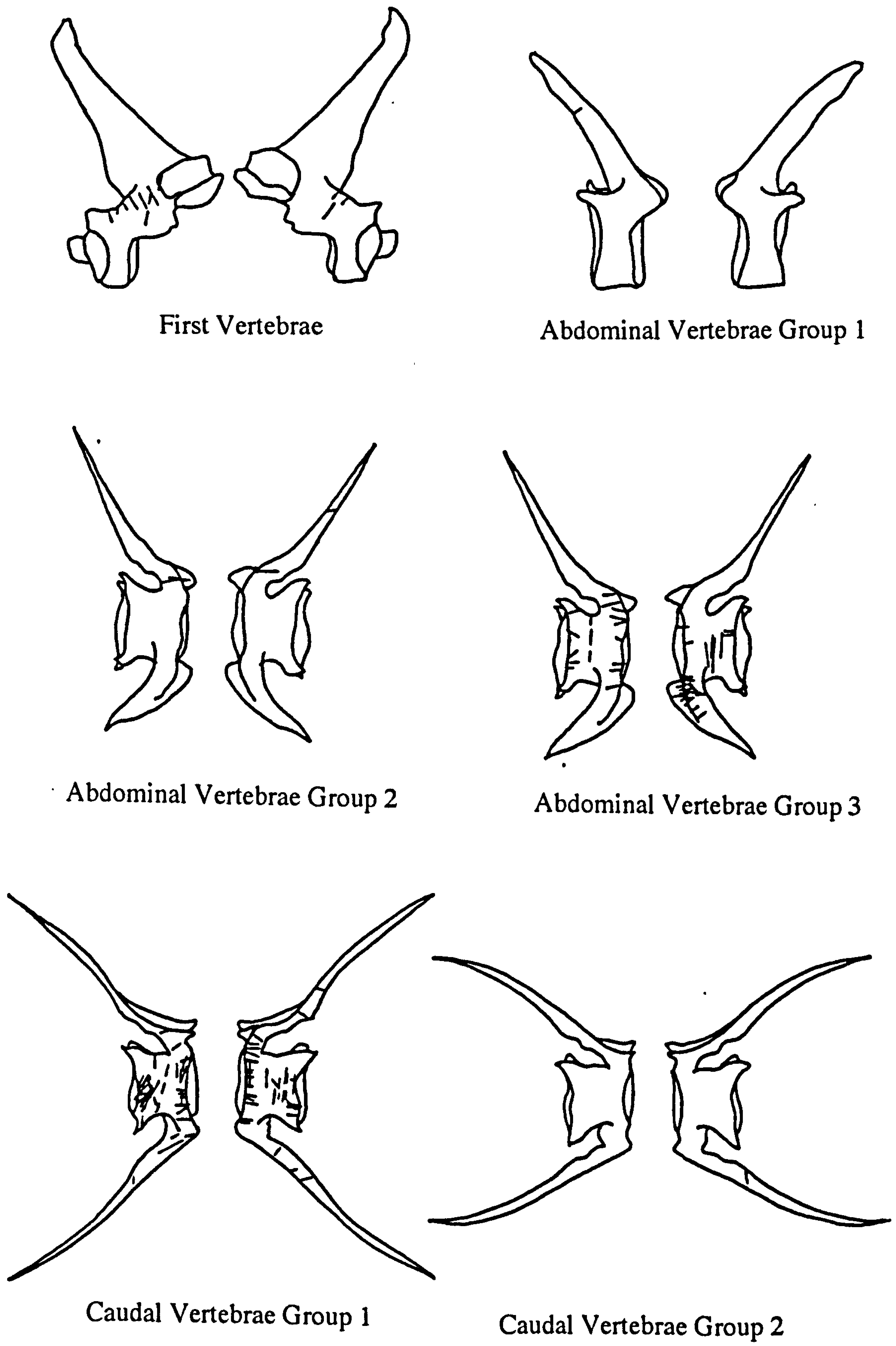


Figure 8.10. Robert's Haven Area A, cut marks observed on cod vertebrae.

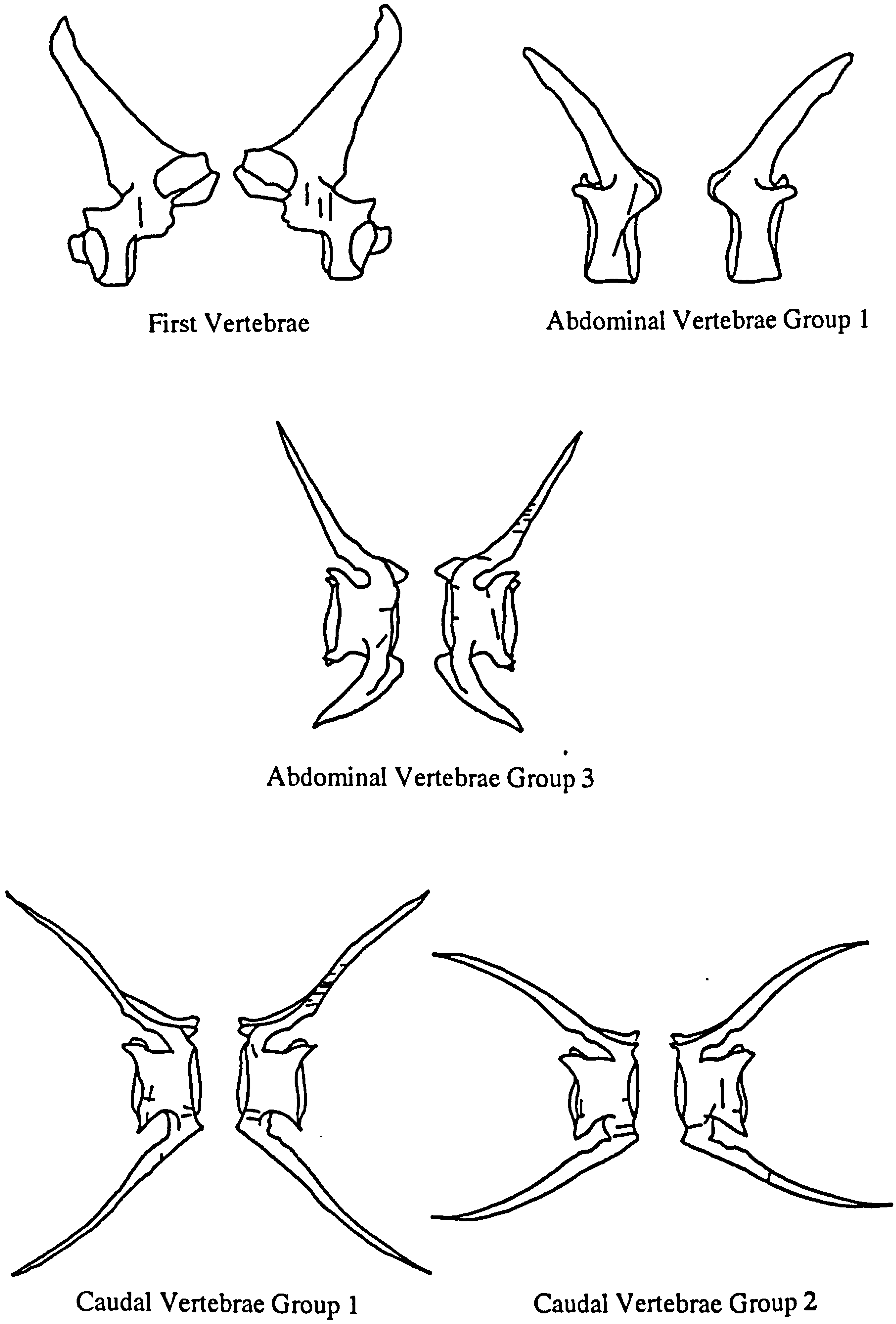


Figure 8.11. Robert's Haven Area A, cut marks observed on saith vertebrae.

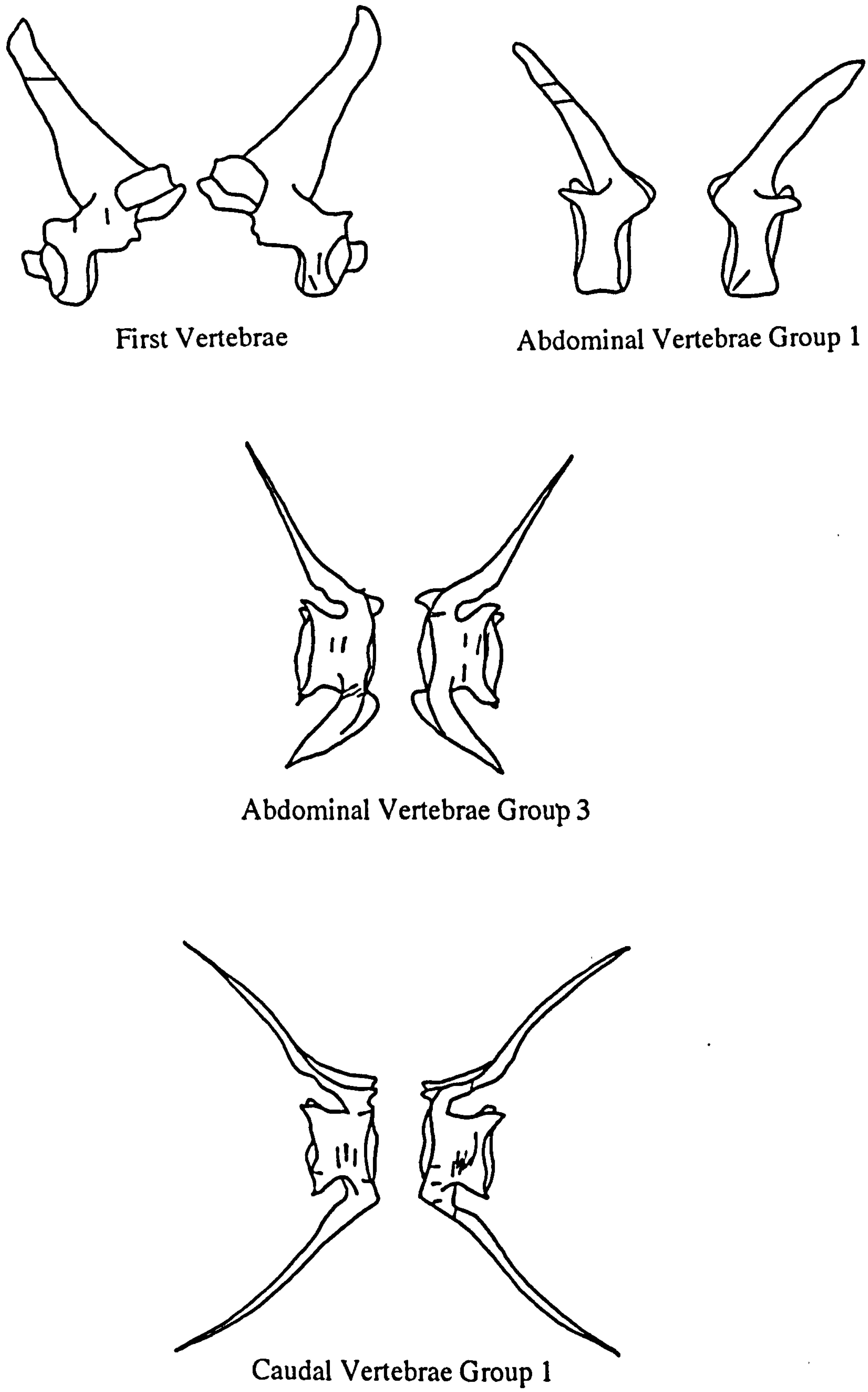


Figure 8.12. Robert's Haven Area A, cut marks observed on ling vertebrae.

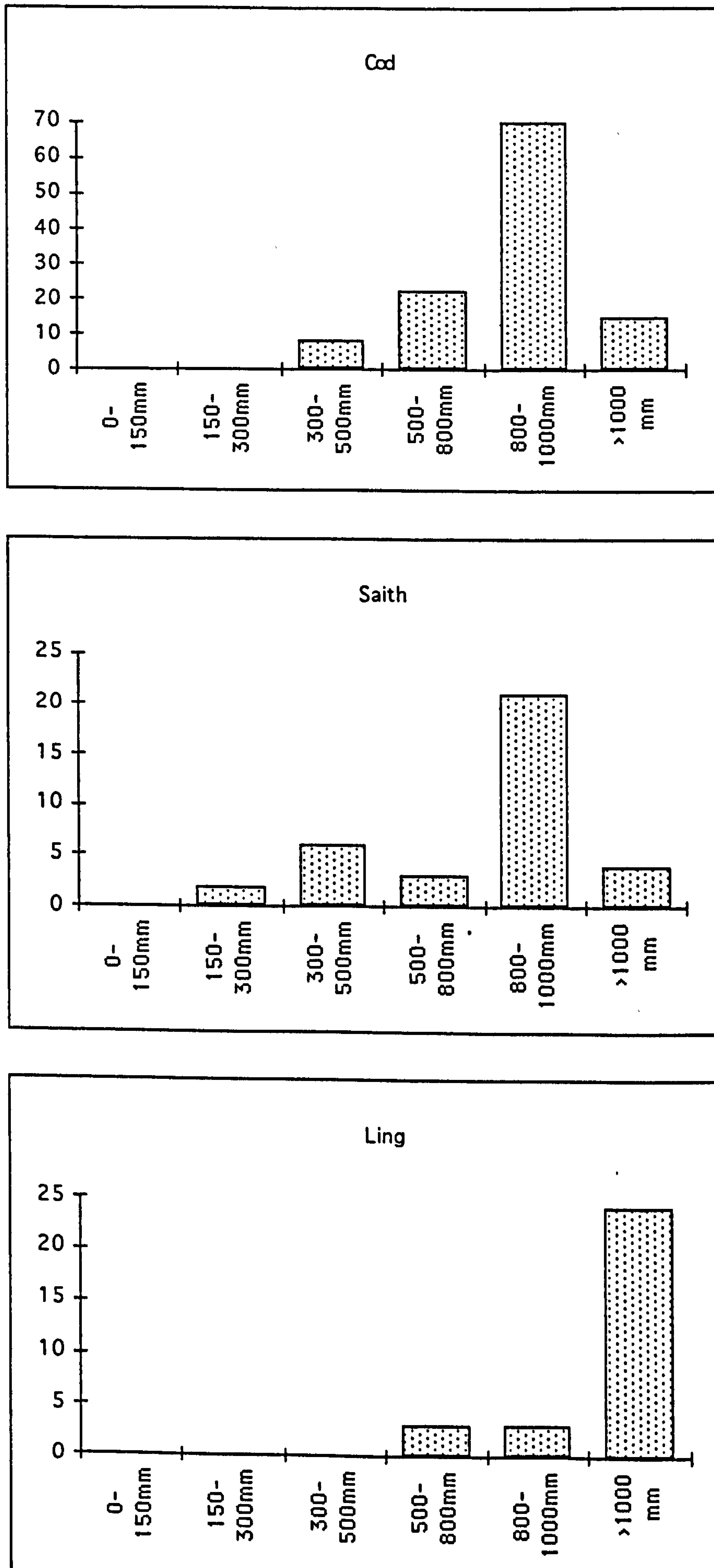


Figure 8.13. Robert's Haven Area A, estimated total length distributions based on cod, saith and ling specimens with evidence of butchery.

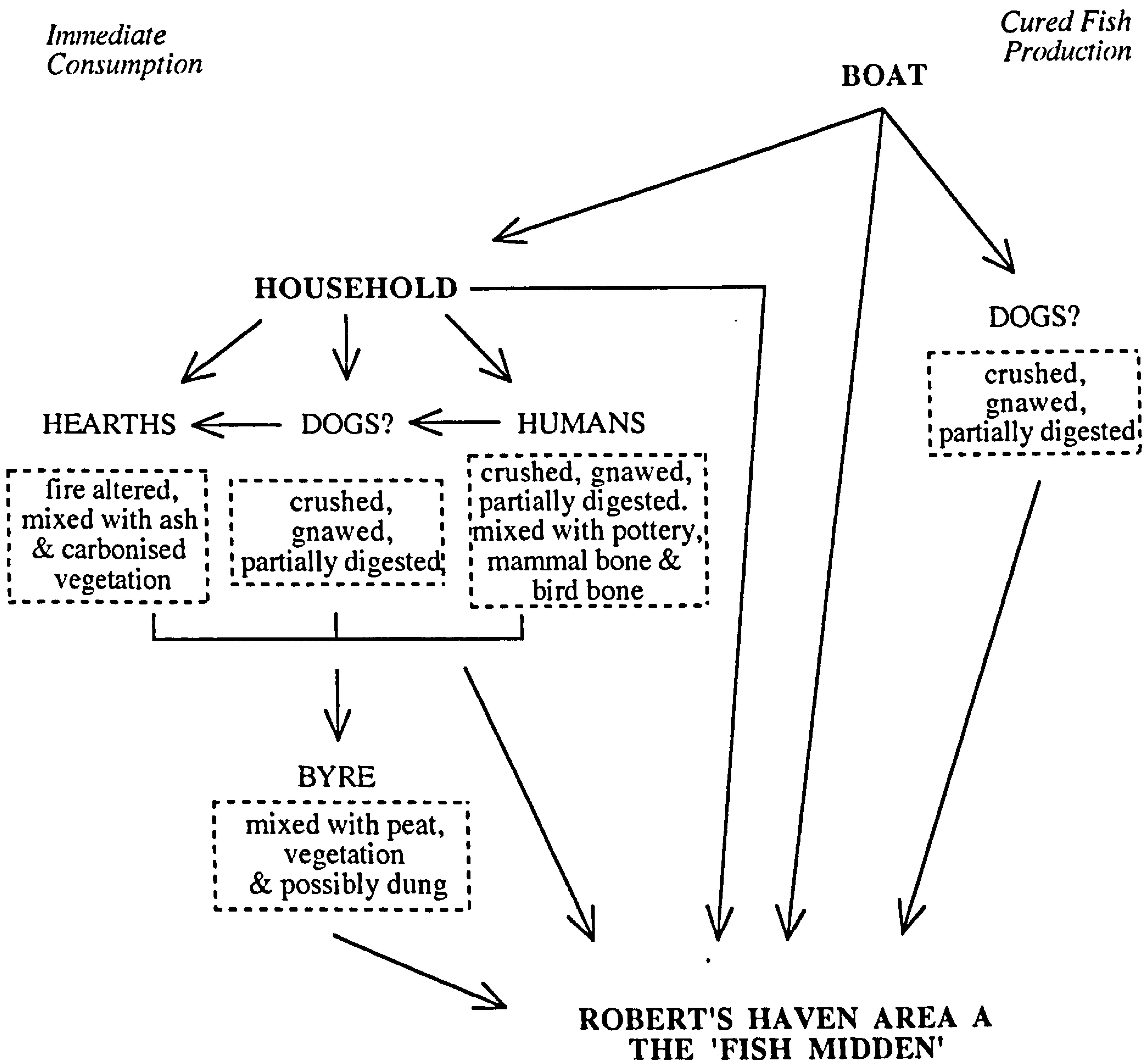


Figure 8.14. Taphonomic pathways of fish bone in Area A at Robert's Haven.

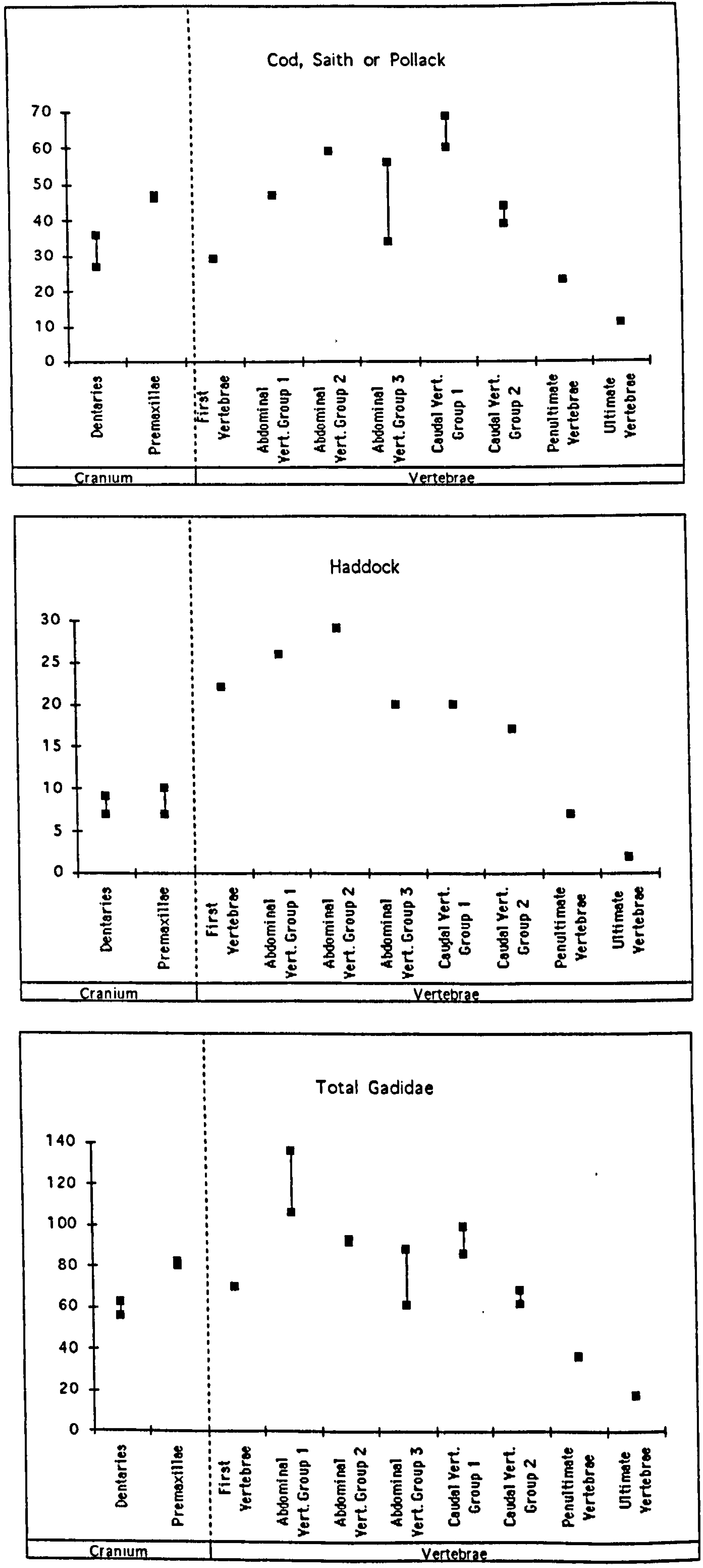


Figure 8.15. Earl's Bu, abundance of vertebrae and two cranial elements (sorted from both >4mm and <4mm sample fractions) for the most common gadoid taxa. The fragment count for each group of vertebrae is divided by the number in a single fish. A range of values is sometimes caused by inter-specific variability in anatomy, or (for dentaries and premaxillae) the difference between right and left elements.

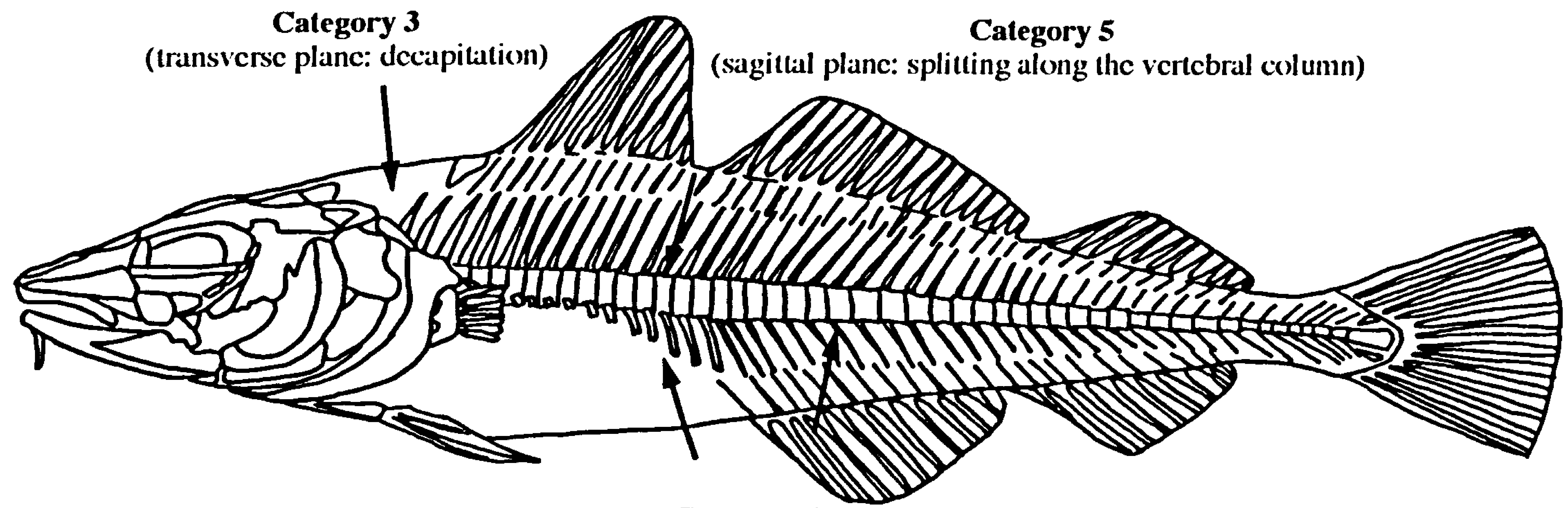


Figure 8.16. Earl's Bu, locations of butchery on the gadoid skeleton (base drawing after Brinkhuizen 1994:199).

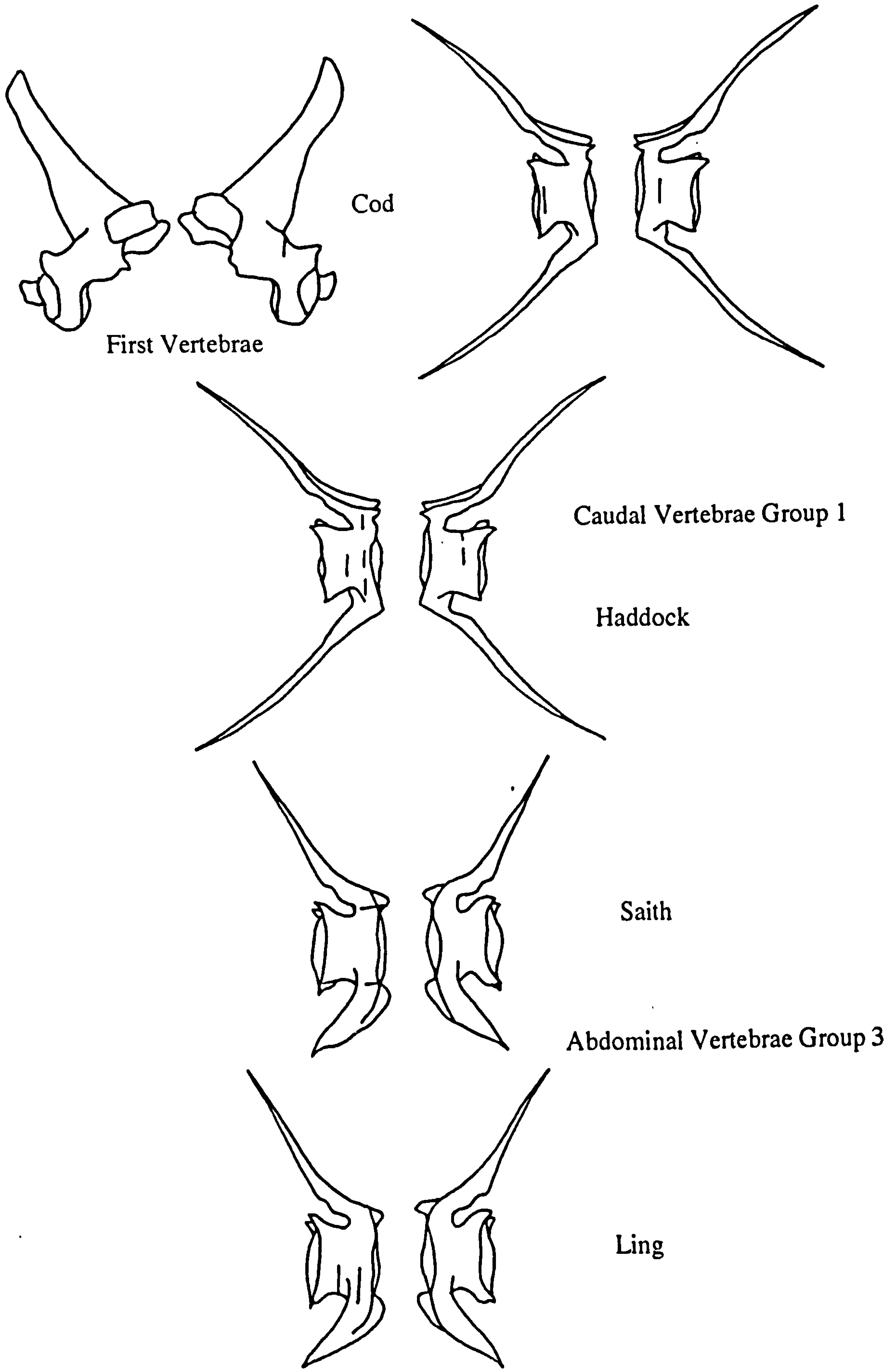
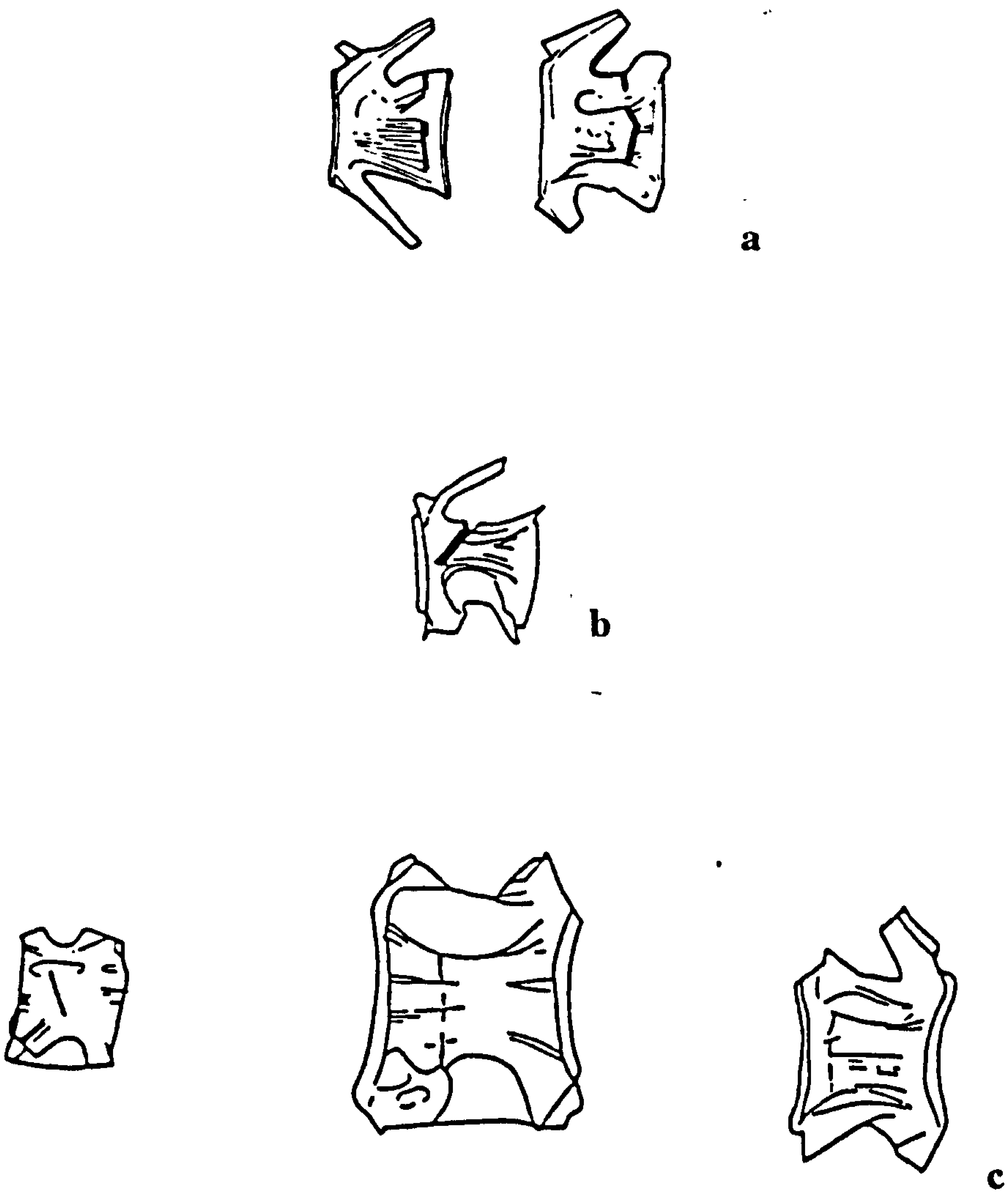


Figure 8.17. Earl's Bu, cut marks observed on cod, haddock, saith and ling vertebrae.



a

b

c

Figure 8.18. Possible category 6 cut marks (caused by severing the vertebral column) observed on gadoid elements from Brough Road Areas 1 and 2 (a), Quoygrew (b) and Tuquoy (c) (from Colley 1983a:250, 261; 1989:256).

Table 1.1

Relative representation of gadoid skeletal elements from four Orcadian fish bone assemblages: Brough Road Areas 1 & 2, Quoygrew, Tuquoy and St. Boniface.

Anatomical Location	Element	No. Per Fish	Brough Road Areas 1&2 Viking Age (Colley 1989:254)	Quoygrew Late Norse (Colley 1983a:342)	Tuquoy 1982 Late Norse (Colley 1983a:341)	St. Boniface Late Norse (Cerón-Carrasco 1994:209)
Cranial	Articular	2	98	100	63	34
	Basihyal	1	13	22	13	
	Basioccipital	1	31	50	31	15
	Ceratohyal	2	49	58	52	41
	Dentary	2	82	107	76	58
	Ectopterygoid	2	20	29	5	12
	Epihyal	2	19	28	27	44
	Ethmoid	1	6	11	1	
	Hyomandibular	2	56	64	48	46
	Interhyal	2	10	19	5	
	Interopercular	2	0	12	1	
	Maxilla	2	71	112	72	45
	Opercular	2	30	27	12	17
	Otolith	2	57	32	88	13
	Palatine	2	26	57	24	4
	Parasphenoid	1	64	61	49	26
	Premaxilla	2	84	119	101	39
	Preopercular	2	33	74	19	25
	Quadrate	2	52	71	60	52
	Symplectic	2	0	21	25	17
	Urohyal	2	25	10	7	
	Vomer	1	45	44	24	23
Appendicular	Posttemporal*	2	49	64	37	24
	Supracleithrum	2	42	54	36	38
	Cleithrum	2	49	56	37	7
Tail	Vertebra	49-67**	1516	4310	2972	2687

*for interpretive purposes
**depending on taxon, see text

Table 1.2

Percentage fragment completeness values for tumbled and trampled cod skeletons

Anatomical Location	Element	Tumbled (1 Cod) (Nicholson 1992b:145)	Trampled (Mean of 3 Cod) (Nicholson 1991:206)
Cranial	Articular	90	75
	Basioccipital	70	90
	Ceratohyal	70	90
	Dentary	80	90
	Ectopterygoid	85	65
	Epihyal	0	100
	Ethmoid	60	100
	Frontal	60	55
	Hyomandibular	60	60
	Hypohyal	75	75
	Interopercular	85	75
	Lacrimal	0	30
	Maxilla	80	95
	Opercular	40	75
	Palatine	80	80
	Parasphenoid	70	65
	Prefrontal	0	50
	Premaxilla	90	100
	Preopercular	80	70
	Quadrate	70	90
	Supraoccipital	0	80
	Symplectic	100	100
	Urohyal	90	90
	Vomer	70	75
Appendicular	Posttemporal*	65	100
	Supracleithrum	85	100
	Cleithrum	45	95
	Scapula	0	0
	Coracoid	0	30
	Basipterygium	10	65
Tail	Abdominal vert.	80	85
	Caudal vert.	40	80

*for interpretive purposes

Table 1.3

Relative representation of gadoid skeletal elements from Freswick Links, Caithness, all phases
(data from Jones 1991a:246-248)

Taxa	Otoliths	Dentaries	Premaxillae	Cleithra
Cod Family	237	48	65	139
Cod	692	287	411	23
Haddock	62	5	20	52
Saith and Pollack	910	103	117	2
Ling	130	108	117	63
Other Cod Family taxa	36	5	11	1
Total	2067	556	741	280

Table 1.4

Relative representation of gadoid skeletal elements from Pool, Orkney, phases 7 and 8 (data from Nicholson n.d.b)

Anatomical Location	Element	Phase 7 Mean Proportional Representation* (MNI =156)	Phase 8 Mean Proportional Representation* (MNI = 236)
Cranial	Articular	43.2	48.6
	Basioccipital	32.1	20.4
	Ceratohyal	28.5	33.3
	Dentary	52.1	56.8
	Ectopterygoid	8.8	12.5
	Epihyal	6.7	8.1
	Ethmoid	5.8	4.1
	Frontal	2.9	2.5
	Hyomandibular	25.3	21.1
	Hypohyal	0.8	0.8
	Interopercular	5.8	5.0
	Lacrimal	1.2	3.4
	Maxilla	27.2	34.9
	Opercular	14.2	6.0
	Palatine	11.5	13.5
	Parasphenoid	70.4	74.8
	Premaxilla	30.3	31.6
	Preopercular	10.8	15.3
	Quadrate	26.5	21.0
	Symplectic	10.3	4.2
	Urohyal	2.9	7.5
	Vomer	22.9	21.7
Appendicular	Posttemporal**	21.1	13.7
	Supracleithrum	15.0	20.4
	Cleithrum	27.2	34.1
	Basipterygium	0.0	1.2
Tail	First Vertebra	27.3	25.3
	Abdominal Vertebra	58.9	36.5
	Caudal Vertebra	25.0	12.1

* see text
** for interpretive purposes

Table 3.1

Viking Age and Late Norse graves in Orkney, Caithness and Shetland (see Appendix 3.3 for references)

Quality of Evidence	Explanation	Orkney	Orkney	Caithness (including Sutherland)	Caithness (including Sutherland)	Shetland	Shetland	Total Viking Age	Total Late Norse (?)
		Viking Age Graves	Late Norse (?) Graves	Viking Age Graves	Late Norse Graves	Viking Age Graves	Late Norse (?) Graves		
a	Complete Records	13	5		7		25	13	37
b	Complete Records of Partially Eroded Burials	4		1				5	
c	Graves Which may be Incompletely Recorded or Published	23		8		2		33	
d	Stray Find of Typical Grave-Good in a Churchyard					1		1	
e	Stray Find of Typical Grave-Good	3		6				9	
Totals		43	5	15	7	3	25	61	37

Table 4.1

Incidence of Grave-goods in Viking Age and Late Norse Graves
(excluding stray finds of objects which could be from graves)

Period	Burials with Grave-goods	Burials without Grave-goods	Burials without Grave-goods which are of Children or for which Dating is Uncertain
Viking Age	12	3	3
Viking Age 1?	25	2	2
Viking Age 2?	8		
Viking Age Total	45	5	5
Viking Age 2 or Late Norse 1		5	3
Late Norse 1		6	not relevant
Late Norse 2	1	26	not relevant
Late Norse Total	1	32	not relevant

Table 5.1a

Principal zooarchaeological assemblages from Norse sites in Orkney

Assemblage	Features Sampled	Viking Age: VA	VA 1	VA2	Late Norse: LN	LN1	LN2	Faunal Report	Sieving	Ammount Sieved	Mesh Size for Bone Recovery	Notes (Mammal)	Notes (Bird)	Notes (Fish)	Is Inter-class Comparison of Fragment Counts Possible?	References
St. Boniface Phase 8	midden				√			yes	yes	total	1mm	UI fragments not recorded	full recording	full recording, but not all elements identified to species	no	Cerón-Carrasco 1993; 1994, forthcoming; Hamilton-Dyer forthcoming; Lowe 1990; 1993; pers comm.; McCormick forthcoming
Quoygrew	midden				√			fish only	yes	total	1.5mm	-	-	class level: all specimens recorded; intra-class level: full recording for non-gadoid taxa, but only 16 diagnostic elements identified below family level for gadoid taxa	no	Colley 1983a; 1984
Tuquoy Area F	occupation & midden				√	√	√	bird & fish only	yes	partial	1mm, 5mm	-	full recording	class level: all specimens recorded; intra-class level: full recording for non-gadoid taxa, but only 17 diagnostic elements identified below family level for gadoid taxa	no	Colley 1983a; 1984; 1988; Hamilton-Dyer 1991; Owen 1993, pers comm.
Pool Phase 7	occupation & midden	√	√					yes	yes	minimal	3mm, 10mm	full recording	full recording	full recording, but not all Gadidae elements identified to species	yes	Bond 1994; forthcoming; pers comm.; Hunter pers comm.; Hunter et al. 1990; 1993; Nicholson n.d. b; Serjeantson forthcoming
Pool Phase 8	occupation & midden	√		√	√	√		yes	yes	minimal	3mm, 10mm	full recording	full recording	full recording, but not all Gadidae elements identified to species	yes	Bond 1994; forthcoming; pers comm.; Hunter pers comm.; Hunter et al. 1990; 1993; Nicholson n.d. b; Serjeantson forthcoming
Brough of Birsay Room 5	occupation & fill deposits	√		√				yes	yes	?	5mm	UI fragments not recorded	to class only	identifications suspect, UI fragments not recorded	no	Donaldson et al. 1981; Hunter & Morris 1982; Seller 1982
Brough of Birsay Sites VII-IX Phase 2	occupation & midden	√		√				yes	yes	?	5mm	full recording?, hare identifications suspect	essentially to class only	to class only	yes?	Hunter 1986; Seller 1986
Brough of Birsay Sites VII-IX Phase 3	occupation & midden				√	√		yes	yes	?	5mm	full recording?, hare identifications suspect	essentially to class only	to class only	yes?	Hunter 1986; Seller 1986
Buckquoy Settlement	occupation & midden	√						yes	no	-	-	UI fragments not recorded	full recording	essentially presence data only	no	Bramwell 1976-1977; Noddle 1976-1977; Ritchie 1976-1977; Wheeler 1976-1977
Brough Road Areas 1 & 2	midden & grave fill	√						yes	yes	partial	10mm, a few samples to 0.85mm	full recording	full recording	class level: all specimens recorded; intra-class level: full recording for non-gadoid taxa, but only 20 diagnostic elements identified below family level for gadoid taxa	yes	Allison 1989; Colley 1989; Morris 1989; Rackham 1989
Beachview Burnside Area 2 (Hand Collected Areas)	midden				√	√		yes	no	-	-	tiny UI fragments not recorded	full recording?	as at Brough Road Areas 1 & 2	yes	Morris forthcoming a; Rackham et al. forthcoming a; forthcoming d
Beachview Burnside Area 2 (Sieved Areas)	midden				√	√		yes	yes	total	0.895mm	tiny UI fragments not recorded	full recording?	as at Brough Road Areas 1 & 2	yes	Morris forthcoming a; Rackham et al. forthcoming a; forthcoming d
Beachview Studio Site (Hand Collected Assemblage)	occupation & midden				√	√		yes	no	-	-	full recording?	full recording?	as at Brough Road Areas 1 & 2	yes	Morris forthcoming a; Rackham et al. forthcoming b; forthcoming c; forthcoming d
Beachview Studio Site (Sieved Assemblage)	occupation & midden				√	√		yes	yes	total	0.895mm	full recording?	full recording?	as at Brough Road Areas 1 & 2	yes	Morris forthcoming a; Rackham et al. forthcoming b; forthcoming c; forthcoming d

Table 5.1a (continued)

Principal zooarchaeological assemblages from Norse sites in Orkney

Assemblage	Features Sampled	Viking Age VA	*VA 1*	*VA2*	Late Norse LN	*LN1*	*LN2*	Faunal Report	Sieving	Ammount Sieved	Mesh Size for Bone Recovery	Notes (Mammal)	Notes (Bird)	Notes (Fish)	Is Inter-class Comparison of Fragment Counts Possible?	References
Saevar Howe	occupation & midden	√						yes	yes	total	5mm	UI fragments not recorded	UI fragments not recorded	class level. all specimens recorded; intra-class level: full recording for non-gadoid taxa, but only 10 diagnostic elements identified below family level for gadoid taxa	no	Colley 1983c; 1984; Hedges 1983; Rowley-Conwy 1983
Brough of Deerness	chapel	√			√	√	√	yes	yes	minimal	0.6mm, 0.85mm, 1.7mm	not considered in this study	not considered in this study	not considered in this study	not considered	Morris & Emery 1986; Rackham 1986
Skaill, Deerness	occupation & midden	√			√?			yes	no	-	-	UI fragments not recorded; phasing differs from bird & fish reports	full recording; phasing differs from mammal & fish reports	full recording; phasing differs from mammal & bird reports	no	Allison forthcoming a; Buteux forthcoming; Gelling 1984; Nicholson n.d. a; Noddle forthcoming
Earl's Bu Sieved LN2? Strata	midden				√		√?	preliminary	yes	'total' see Section 5.3.1	4mm, selected fish elements to 1mm	full recording	full recording	class level: all specimens recorded; intra-class level: 9 elements identified to species; see Sections 5.3.1 and 8.3.2	yes	Batey 1993a; Batey & Morris 1992; pers comm.; Mainland n.d.; 1993; 1994; pers comm.

Table 5.1b

Principal zooarchaeological assemblages from Norse sites in Caithness

Assemblage	Features Sampled	Viking Age: VA	Viking Age: VA 1	Viking Age: VA2	Late Norse: LN	Late Norse: LN1	Late Norse: LN2	Faunal Report	Sieving	Ammount Sieved	Mesh Size for Bone Recovery	Notes (Mammal)	Notes (Bird)	Notes (Fish)	Is Inter-class Comparison of Fragment Counts Possible?	References
Robert's Haven Area A	midden				√		√	yes	yes	total	4mm, selected fish elements to 1mm	full recording	full recording	class level: all specimens recorded; intra-class level: 9 elements identified to species; see Sections 5.3.2 and 8.3.2	yes	this study; Mainland pers comm.; Morris et al. 1994; O'Sullivan pers comm.
Freswick Links, Northern Cliff Areas	midden & cultivation horizons	predominately Late Norse, see Figure 5.13						yes	yes	partial (mammal & bird), total (fish)	1mm, selective sorting	full recording of sorted specimens only	full recording of sorted specimens only	full recording of non-gadid taxa; only 4 diagnostic elements identified for abundant Gadidae species	no	Allison forthcoming b; Batey 1987; Gidney forthcoming; Hibberd forthcoming; Jones 1991a; Jones et al. forthcoming a; forthcoming b; Morris et al. forthcoming a
Freswick Links, Middle Cliff Areas	occupation & midden	predominately Late Norse, see Figures 5.14-5.15						yes	yes	partial (mammal & bird), total (fish)	1mm, selective sorting	full recording of sorted specimens only	full recording of sorted specimens only	full recording of non-gadid taxa; only 4 diagnostic elements identified for abundant Gadidae species	no	Allison forthcoming b; Batey 1987; Gidney forthcoming; Hibberd forthcoming; Jones 1991a; Jones et al. forthcoming a; forthcoming b; Morris et al. forthcoming a
Freswick Links, Southern Cliff Areas	midden & cultivation horizons	predominately Pictish, see Figure 5.16						yes	yes	partial (mammal & bird), total (fish)	1mm, selective sorting	full recording of sorted specimens only	full recording of sorted specimens only	full recording of non-gadid taxa; only 4 diagnostic elements identified for abundant Gadidae species	no	Allison forthcoming b; Batey 1987; Gidney forthcoming; Hibberd forthcoming; Jones 1991a; Jones et al. forthcoming a; forthcoming b; Morris et al. forthcoming a
Freswick Links, Area 3	disturbed midden	mixed Late Norse & Pictish, see Figure 5.17						yes	yes	partial (mammal & bird), total (fish)	1mm, selective sorting	full recording of sorted specimens only	full recording of sorted specimens only	full recording of non-gadid taxa; only 4 diagnostic elements identified for abundant Gadidae species	no	Allison forthcoming b; Batey 1987; Gidney forthcoming; Hibberd forthcoming; Jones 1991a; Jones et al. forthcoming a; forthcoming b; Morris et al. forthcoming a
Freswick Links, Area 9	middens				√?			yes	yes	partial (mammal & bird), total (fish)	1mm, selective sorting	full recording of sorted specimens only	full recording of sorted specimens only	full recording of non-gadid taxa; only 4 diagnostic elements identified for abundant Gadidae species	no	Allison forthcoming b; Batey 1987; Gidney forthcoming; Hibberd forthcoming; Jones 1991a; Jones et al. forthcoming a; forthcoming b; Morris et al. forthcoming a
Freswick Castle	occupation & midden				√?			yes, mixed with postmedieval	yes	minimal	0.85mm	full recording	full recording	essentially presence data only	no	Batey et al. 1984

Table 5.1c

Principal zooarchaeological assemblages from Norse sites in Shetland

Assemblage	Features Sampled	VA (Viking Age)	*VA 1*	*VA2*	LN (Late Norse)	*LN1*	*LN2*	Faunal Report	Sieving	Ammount Sieved	Mesh Size for Bone Recovery	Notes (Mammal)	Notes (Bird)	Notes (Fish)	Is Inter-class Comparison of Fragment Counts Possible?	References
Sandwick, MU 3 & 4 Early	midden				√	√		preliminary	yes	substantial	1.5mm, 3mm	full recording	full recording	only 6 diagnostic elements identified	no	Bigelow 1984; 1985; 1989
Sandwick, MU2, MU3 & 4 Middle-Late	midden				√		√	preliminary	yes	substantial	1.5mm, 3mm	full recording	full recording	only 6 diagnostic elements identified	no	Bigelow 1984; 1985; 1989
Jarlshof	occupation & midden	√	√?	√	√	√	√	cursory	no	-	-	selective presence data only	selective presence data only	selective presence data only	no	Ashmore 1993; Hamilton 1956; Platt 1956

Table 5.2a

Principal botanical assemblages from Norse sites in Orkney

Assemblage	Features Sampled	VA (Viking Age)	VA1	VA2	LN (Late Norse)	LN1	LN2	Botanical Report	Sieving	Ammount Sieved	Mesh Size	References
Tuquoy Area F	occupation & midden				√	√	√	yes	yes	?	1mm	Nye & Boardman n.d.; Owen 1993; pers comm.
Tuquoy Area J	waterlogged pit	√						yes	yes	minimal	0.25mm, 0.5mm	Jones n.d.; Nye & Boardman n.d.; Owen 1993; Tipping n.d.; Crone n
Pool Phase 7	occupation & midden	√	√					yes	yes	minimal	0.5mm	Bond 1994; pers comm.
Pool Phase 8	occupation & midden	√		√	√	√		yes	yes	minimal	0.5mm	Bond 1994; pers comm.
Brough of Birsay Room 5	occupation & fill deposits	√		√				yes (charcoal only)	?	?	?	Donaldson 1982; Donaldson et al. 1981; Hunter & Morris 1982
Brough of Birsay Sites VII-IX Phase 2	occupation & midden	√		√				yes	yes	?	0.3mm	Donaldson 1986a, 1986b; Hunter 1986
Brough of Birsay Sites VII-IX Phase 3	occupation & midden				√	√		yes	yes	?	0.3mm	Donaldson 1986a; 1986b; Hunter 1986
Brough Road Area 2	midden	√						yes	yes	minimal	0.85mm, ?	Donaldson & Nye 1989; Morris 1989; Nye & Donaldson 1989; Rackham 1989
Beachview Burnside Area 2	midden				√	√		yes	yes	partial	0.3mm, 0.895mm	Morris forthcoming a; Rackham et al. forthcoming a; forthcoming d
Beachview Studio Site	occupation & midden				√	√		yes	yes	?	0.3mm, 0.895mm	Morris forthcoming a; Rackham et al. forthcoming b; forthcoming c; forthcoming d
Saevar Howe	occupation	√						yes	yes	?	?	Dickson 1983; Hedges 1983
Brough of Deerness (not considered in this study)	chapel	√			√	√	√	yes (charcoal only)	yes	minimal	0.3mm	Donaldson 1986c; Morris & Emery 1986; Rackham 1986
Earl's Bu Sieved LN2? Strata	midden				√		√?	preliminary	yes	'total' see Section 5.3.1	0.5mm	Batey 1993a; pers comm.; Batey & Morris 1992; Huntley 1990; see Section 5.3.1

Table 5.2b

Principal botanical assemblages from Norse sites in Caithness

Assemblage	Features Sampled	VA (Viking Age)	*VA1*	*VA2*	LN (Late Norse)	*LN1*	*LN2*	Botanical Report	Sieving	Ammount Sieved	Mesh Size	References
Robert's Haven Area A	midden				√		√	preliminary	yes	total	0.5mm	Huntley pers comm.; Morris et al. 1994; White 1992; see Section 5.3.2
Freswick Links, Northern Cliff Areas	midden & cultivation horizons	predominately Late Norse, see Figure 5.13						yes	yes	partial	0.5mm	Huntley & Turner forthcoming; Morris et al. forthcoming a; Nye forthcoming; Rackham forthcoming
Freswick Links, Middle Cliff Areas	occupation & midden	predominately Late Norse, see Figures 5.14-5.15						yes	yes	partial	0.5mm	Huntley & Turner forthcoming; Morris et al. forthcoming a; Nye forthcoming; Rackham forthcoming
Freswick Links, Southern Cliff Areas	midden & cultivation horizons	predominately Pictish, see Figure 5.16						yes	yes	partial	0.5mm	Huntley & Turner forthcoming; Morris et al. forthcoming a; Nye forthcoming; Rackham forthcoming
Freswick Links, Area 3	disturbed midden	mixed Late Norse & Pictish, see Figure 5.17						yes	yes	partial	0.5mm	Huntley & Turner forthcoming; Morris et al. forthcoming a; Nye forthcoming; Rackham forthcoming
Freswick Links, Area 9	midden				√?			yes	yes	partial	0.5mm	Huntley & Turner forthcoming; Morris et al. forthcoming a; Nye forthcoming; Rackham forthcoming
Freswick Castle	occupation & midden				√?			yes, mixed with post-medieval	yes	minimal	0.3mm	Batey et al. 1984; Donaldson 1984

Table 5.2c

Principal botanical assemblages from Norse sites in Shetland

Assemblage	Features Sampled	VA (Viking Age)	*VA1*	*VA2*	LN (Late Norse)	*LN1*	*LN2*	Botanical Report	Sieving	Ammount Sieved	Mesh Size	References
Sandwick, MU1	midden				√		√	preliminary	yes	minimal	"tea strainer"	Bigelow 1984; 1985
Jarlshof, Viking Age Phases	midden	√	√?	√				cursory	no	-	-	Ashmore 1993; Hamilton 1956; Orr & Green 1956
Jarlshof, Late Norse Phases	occupation				√		√	cursory	no	-	-	Ashmore 1993; Hamilton 1956; Orr & Green 1956
The Biggings Period 2	occupation				√			preliminary	yes	minimal	?	Crawford 1985a; 1991a; Dickson n.d.

Table 5.3

Estimated weight range of animals used in Viking Age and Late Norse northern Scotland: The effect of animal weight on the ratio of bone weight:total weight in mammals birds and cod family fishes (from Barrett 1994)

Taxonomic Category	Species	Minimum Weight (g)	Percentage Bone	Species	Maximum Weight (g)	Percentage Bone
Mammal	Lamb	1400	5.9	Cow	152000	10.0
Bird	Starling	45	5.3	Mute swan	15000	9.4
Gadoid Fishes	Saith	47	2.1	Ling	56178	3.4

Table 5.4

Confidence intervals for the ratios of bone weight:total fish weight derived in this study for cod family fishes

Minimum % Bone	95% Confidence Interval	Maximum % Bone	95% Confidence Interval
2.1%	1.9%-2.3%	3.4%	3.0%-3.7%

Table 5.5a

A summary of the mammal remains (by fragment count) in 10 faunal assemblages from Orkney and Caithness which predominately date to the Viking Age (see Table 5.1 for references)

Order	Common Name	Taxon	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Areas 1 & 2	Buckquoy	Brough of Birsay, Room 5	Saevar Howe	Skaill, Deerness	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Insectivora	Pygmy Shrew	*Sorex minutus*										
Lagomorpha	Rabbit	*Oryctolagus cuniculus*	33	74	506	2	101					
	Brown/Mountain Hare	*Lepus europaeus/timidus*										11
Rodentia	Rodent Order	Rodentia			4							
	Vole	*Clethrionomys/Microtus/Arvicola*			26	15	3					
	Bank Vole	*Clethrionomys glareolus*			1							
	Orkney Vole	*Microtus arvalis*			11							
	Water Vole	*Arvicola terrestris*										
	Mouse	*Apodemus/Mus*				2						
	Wood Mouse	*Apodemus sylvaticus*										
	House Mouse	*Mus musculus*										
	Ship/Common Rat	*Rattus rattus/norvegicus*				4	16					4
	Common Rat	*Rattus norvegicus*										
Cetacea	Whale Order	Cetacea			5	8				79	45	
Carnivora	Carnivore Order	Carnivora										
	Dog/Fox	*Canis familiaris/Vulpes vulpes*										
	Dog	*Canis familiaris*	1			4					12	
	Stoat	*Mustela erminea*		1								
	Otter	*Lutra lutra*			2		6			24	4	
	Wild/Domestic Cat	*Felis silvestris/catus*	44	2	1	34		10		39	163	
Pinnipedia	Seal Family	Phocidae			16	14			111	26	6	
	Grey Seal	*Halichoerus grypus*										
Perissodactyla	Horse	*Equus caballus*	5		15	67		11	114	259	134	
Artiodactyla	Pig	*Sus scrofa*	30	11	162	466	85	38	696	971	367	155
	Deer Family	Cervidae							51			15
	Red Deer	*Cervus elaphus*	4		56	8				136	31	
	Roe Deer	*Capreolus capreolus*				1						
	Cattle	*Bos taurus*	174	78	197	1396	673	79	2751	3510	1655	1374
	Sheep/Goat	*Ovis/Capra*	75	20	150	868	967	104	2263	4886	1979	1071
	Goat	*Capra hircus*				36		1	2			
	Sheep	*Ovis aries*						12				
Other	Rodent Size	Rodent Size										
	Small Mammal	Small Mammal			22					6	6	
	Small Hoofed Mammal	Small Ungulate	280	29	258					635	460	
	Medium Mammal	Medium Mammal			1043							
	Large Hoofed Mammal	Large Ungulate	110	25	101					299	373	
	Large Mammal	Large Mammal	263	71	1236							
	Other	Other							36			
	Unidentified Mammal	Unidentified Mammal	3859	704	257					6518	2342	3396
	Total Mammal	Total Mammal	4878	1015	4069	2925	1851	255	6024	17388	7577	6026

Table 5.5b

A summary of the mammal remains (by fragment count) in 14 faunal assemblages from Orkney, Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.1 for references)

Order	Common Name	Taxa	Brough of Birsay, Sites VII-IX Phase 3	Freswick Links, Area 9	Freswick Links, MCA	Freswick Links, NCA	St. Boniface, Phase 8	Beachview Burnside Area 2 (Hand Collected)	Beachview Burnside Area 2 (Sieved Areas)	Beachview Studio Site (Hand Collected Bone)	Beachview Studio Site (Sieved Bone)	Sandwick, MU3 & 4 Early	Sandwick, MU2, MU 3 & 4 Middle-Late	Earl's Bu, selected LN contexts	Robert's Haven, Area A	Freswick Castle
Insectivora	Pygmy Shrew	*Sorex minutus*							6							
Lagomorpha	Rabbit	*Oryctolagus cuniculus*		2	11	20				6	4					2
	Brown/Mountain Hare	*Lepus europaeus/timidus*	47			18										
Rodentia	Rodent Order	Rodentia							733	14	32			3		21
	Vole	*Clethrionomys/Microtus/Arvicola*							490	2	1					
	Bank Vole	*Clethrionomys glareolus*														
	Orkney Vole	*Microtus arvalis*	6						57	1	4					
	Water Vole	*Arvicola terrestris*			present	present										
	Mouse	*Apodemus/Mus*							241	6	7					
	Wood Mouse	*Apodemus sylvaticus*							99	8						1
	House Mouse	*Mus musculus*							161	2	12					2
	Ship/Common Rat	*Rattus rattus/norvegicus*	9													16
	Common Rat	*Rattus norvegicus*														2
Cetacea	Whale Order	Cetacea			10							1	7			
Carnivora	Carnivore Order	Carnivora						3	1	4						
	Dog/Fox	*Canis familiaris/Vulpes vulpes*		16				1								
	Dog	*Canis familiaris*						1	1	2		1	12	43		2
	Stoat	*Mustela erminea*														
	Otter	*Lutra lutra*											1			
	Wild/Domestic Cat	*Felis silvestris/catus*			46	2	22	5	15	7	5	3	7	52	1	
Pinnipedia	Seal Family	Phocidae						2		17	1					
	Grey Seal	*Halichoerus grypus*					1		1	9						
Perissodactyla	Horse	*Equus caballus*			4	2		15		5		2	13			
Artiodactyla	Pig	*Sus scrofa*	82		9	2	23	101	34	145	15	7	16	238	3	6
	Deer Family	Cervidae	10						2							
	Red Deer	*Cervus elaphus*			1	1	1	1	1							
	Roe Deer	*Capreolus capreolus*		1												
	Cattle	*Bos taurus*	920	22	382	224	66	168	67	284	11	116	577	452	16	21
	Sheep/Goat	*Ovis/Capra*	986	7	33	17	133	124	102	734	145	69	209	210	5	38
	Goat	*Capra hircus*														
	Sheep	*Ovis aries*			1			1		3		16	21			
Other	Rodent Size	Rodent Size		present	present	present								23		
	Small Mammal	Small Mammal						2	696	12		108	415	165	3	
	Small Hoofed Mammal	Small Ungulate		17	248	166		281	228	735	564			2810	74	22
	Medium Mammal	Medium Mammal								615						
	Large Hoofed Mammal	Large Ungulate		7	202	102		275	84	166	12			2649	54	6
	Large Mammal	Large Mammal		13	163	115				226	16	37	194			24
	Other	Other														
	Unidentified Mammal	Unidentified Mammal	1485	127	2985	1420		484+	8954+	1248	127	362	2211	19430	517	233
	Total Mammal	Total Mammal	3545	212	4095	2089	246	1464+	11973+	4251	956	722	3683	26075	673	396

Table 5.6a

A summary of the fish remains (by fragment count) in 10 faunal assemblages from Orkney and Caithness which predominately date to the Viking Age (see Table 5.1 for references)

Group	Common Name	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Areas 1 & 2	Buckquoy	Brough of Birsay, Room 5	Saevar Howe	Skaill, Deerness	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Selachii	Shark, Skate, Ray & Chimaera Class										
	Shark Order			1							
	Shark, Skate & Ray Orders	1			present				2	1	
	Dogfish Family	1	1	4							
	Dogfish Families							2			
	Smallspotted Catshark										
	Tope Shark							1			
	Spurdog								1	5	
	Ray Family					3					
	Thornback Ray	1									
Clupeidae	Atlantic Herring	9	2								
Salmonidae	Salmon & Trout Family		3								
	Salmon/Trout			4							
	Atlantic Salmon						1				
	Trout				present						
Anguillidae	Eel	1									
Congridae	Conger Eel	1		4	present		2	14	9	5	
Belonidae	Garfish										
Merlucciidae	Hake			13	present		2		1	6	
Gadidae	Cod Family	33	25	2705	present		513		1682	1183	
	Cod/Saith/Pollack						166	220	819	564	
	Cod	80	146	1069	present	506	130	780	1371	1659	
	Haddock	2	3	2	present				8	66	
	Whiting								2	1	
	Saith/Pollack			3				83	86	47	
	Pollack	2		8				165	39	24	
	Saith	114	41	396	present		26	250	343	208	
	Norway Pout/Bib/Poor-cod	2	3								
	Bib	1									
	Torsk			19			1				
	Rockling	1		2							
	Five-bearded/Northern Rockling										
	Five-bearded Rockling										
	Shore Rockling						1				
	Three-bearded Rockling										
	Ling	17	3	131	present		17	98	74	517	
	Tadpole-fish										
Moronidae	European Seabass							2			
Carangidae	Atlantic Horse-mackerel	1	9								
Sparidae	Sea Bream Family								132	3	
	Red Sea Bream			2	present		2			27	
	Black Sea Bream								2		
Labridae	Wrasse Family	1	1					5	5	1	
	Ballan Wrasse			49	present		6	4	1		
	Cuckoo Wrasse							2			
	Corkwing										
Ammodytidae	Sand Eel Family										
	Greater Sand-eel										
Scombridae	Tuna								2		
	Atlantic Mackerel		1		present	7		2			
Callionymidae	Dragonet										
Anarhichadidae	Wolf-fish	5									
Pholididae	Butterfish										
Mugilidae	Thick-lipped Grey Mullet							1			
Triglidae	Gurnard Family	9	1	2				4			
	Red Gurnard										
	Grey Gurnard	4		2	present			43			
Cottidae	Sea Scorpion Family			1			1	2			
	Bullhead										
	Bull-rout			8							
	Sea Scorpion	1	1	1				2			
Agonidae	Hooknose										
Cyclopteridae	Lumpsucker										
Heterosomata	Flatfish Order			1					3	2	
	Turbot Family										
	Megrim							1	7	1	
	Turbot								6	1	
	Topknot										
	Halibut Family	2	7					7	1	1	
	Halibut										
	Dab										
	Lemon Sole										
	Flounder			3							
	Plaice			2			1	7			
	Sole							1			
Lophiidae	Angler									2	
Other	Cod Family Q2 Elements										
	Cod Family Q3 Elements										
	Unidentified Cod Family										
	Not Cod Family Q2 Elements										
	Not Cod Family Q3 Elements										
	Unidentified Fish			6395			643		1974	2070	51
	Unidentified Fish Cranial										
	Unidentified fish vertebrae										
	Unidentified Not Gadidae										
	Total Fish	289	247	10827		516	1512	1696	6570	6394	51

Table 5.6b

A summary of the fish remains (by fragment count) in 15 faunal assemblages from Orkney, Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.1 for references)

Group	Common Name	Brough of Birsay, Sites VII-IX Phase 3	Freswick Links, Area 9	Freswick Links, NCA	Quoygrew	St. Boniface, Phase 8	Tuquoy	Beachview Burnside Area 2 (Hand Collected)	Beachview Burnside Area 2 (Sieved Areas)
Selachii	Shark, Skate, Ray & Chimaera						9		64
	Shark Order						8		
	Shark, Skate & Ray Orders					4			
	Dogfish Family								
	Dogfish Families						63		1
	Smallspotted Catshark						2		
	Tope Shark								9
	Spurdog								
	Ray Family				5		52		
	Thornback Ray					1	6		2
Clupeidae	Atlantic Herring			4	3	35			1
Salmonidae	Salmon & Trout Family		1						
	Salmon/Trout								6
	Atlantic Salmon								
	Trout								
Anguillidae	Eel		1	4	2	1	19		109
Congridae	Conger Eel			27	3	12	8		
Belonidae	Garfish			5					
Merlucciidae	Hake			1			3		
Gadidae	Cod Family		4	124	3074	8163	17129	629	3689
	Cod/Saith/Pollack			17				83	384
	Cod		12	303	1256	362	7894	608	337
	Haddock		5	35	3		168	1	1
	Whiting			1		6	1		
	Saith/Pollack			3					
	Pollack			15	23	161	24	1	1
	Saith		3	267	2731	448	4030	8	884
	Norway Pout/Bib/Poor-cod		1	1					
	Bib								
	Torsk			3					1
	Rockling				10		55		2
	Five-bearded/Northern Rockling			3					
	Five-bearded Rockling						62		
	Shore Rockling				4	3	4		
	Three-bearded Rockling								
	Ling		11	223	216	1	1826	17	40
	Tadpole-fish			4					
Moronidae	European Seabass			1					
Carangidae	Atlantic Horse-mackerel								
Sparidae	Sea Bream Family				1		1		
	Red Sea Bream						1		
	Black Sea Bream			2					
Labridae	Wrasse Family			2			1		7
	Ballan Wrasse			1	3		12		1
	Cuckoo Wrasse			1					
	Corkwing						11		
Ammodytidae	Sand Eel Family				3	22			
	Greater Sand-eel		2						
Scombridae	Tuna								
	Atlantic Mackerel			1	1	1			
Callionymidae	Dragonet								
Anarhichadidae	Wolf-fish			21	1				
Pholididae	Butterfish				9	11	127		5
Mugilidae	Thick-lipped Grey Mullet								
Triglidae	Gurnard Family			3	1				1
	Red Gurnard								
	Grey Gurnard			1					
Cottidae	Sea Scorpion Family				3		14		2
	Bullhead								
	Bull-rout				5	7	20		
	Sea Scorpion			2	1	3	8		
Agonidae	Hooknose								
Cyclopteridae	Lumpsucker				4		1		
Heterosomata	Flatfish Order				4		14		1
	Turbot Family								
	Megrim			6			15		
	Turbot								
	Topknot			4					
	Halibut Family		2	40		7			
	Halibut						2		
	Dab								
	Lemon Sole								1
	Flounder				3		1		
	Plaice						3		5
	Sole								
Lophiidae	Angler			1			55		
Other	Cod Family Q2 Elements								
	Cod Family Q3 Elements								
	Unidentified Cod Family				22030				
	Not Cod Family Q2 Elements								
	Not Cod Family Q3 Elements								
	Unidentified Fish	41			40	15642	109088	1051	53272
	Unidentified Fish Cranial								
	Unidentified fish vertebrae								
	Unidentified Not Gadidae								
	Total Fish	41	42	1126	29439	24890	140737	2398	58826

Table 5.6b (continued)

A summary of the fish remains (by fragment count) in 15 faunal assemblages from Orkney, Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.1 for references)

Group	Common Name	Beachview Studio Site (Hand Collected Bone)	Beachview Studio Site (Sieved Bone)	Sandwick, MU3 & 4 Early	Sandwick, MU2, MU 3 & 4 Middle-Late	Earl's Bu, selected LN contexts	Robert's Haven, Area A	Freswick Castle
Selachii	Shark, Skate, Ray & Chimaera							
	Shark Order							
	Shark, Skate & Ray Orders					1		
	Dogfish Family							
	Dogfish Families							
	Smallspotted Catshark							
	Tope Shark							
	Spurdog					1		
	Ray Family							
	Thornback Ray					1		
Clupeidae	Atlantic Herring	1	1			present		
Salmonidae	Salmon & Trout Family					1		present
	Salmon/Trout	1	8					
	Atlantic Salmon							
	Trout							
Anguillidae	Eel	1	55			4		
Congridae	Conger Eel	7	3			present		
Belonidae	Garfish							
Merlucciidae	Hake	1	1	1	2	3	2	
Gadidae	Cod Family	836	995			378	650	present
	Cod/Saith/Pollack	137	831			2	15	
	Cod	629	227	78	472	459	980	present
	Haddock	3	2	1	3	269	33	
	Whiting				1	4	4	
	Saith/Pollack			41	1420		53	
	Pollack	1		1	7	1	88	
	Saith	45	1319			40	826	present
	Norway Pout/Bib/Poor-cod							
	Bib				1			
	Torsk		10	5	63		8	
	Rockling	1					19	
	Five-bearded/Northern Rockling							
	Five-bearded Rockling					present		
	Shore Rockling		2					
	Three-bearded Rockling					present		
	Ling	55	28	16	209	25	270	present
	Tadpole-fish							
Moronidae	European Seabass							
Carangidae	Atlantic Horse-mackerel					present		
Sparidae	Sea Bream Family							
	Red Sea Bream							
	Black Sea Bream							
Labridae	Wrasse Family		2					
	Ballan Wrasse	6	9		2			
	Cuckoo Wrasse							
	Corkwing							
Ammodytidae	Sand Eel Family							
	Greater Sand-eel							
Scombridae	Tuna							
	Atlantic Mackerel				2	present		
Callionymidae	Dragonet					present		
Anarhichadidae	Wolf-fish							
Pholididae	Butterfish					present		
Mugilidae	Thick-lipped Grey Mullet							
Triglidae	Gurnard Family					present		present
	Red Gurnard					present		
	Grey Gurnard							
Cottidae	Sea Scorpion Family							
	Bullhead							
	Bull-rout	5						
	Sea Scorpion					1		
Agonidae	Hooknose							
Cyclopteridae	Lumpsucker							present
Heterosomata	Flatfish Order				1	present		
	Turbot Family					present		
	Megrim							
	Turbot							
	Topknot							
	Halibut Family					present		
	Halibut		1					
	Dab							
	Lemon Sole							
	Flounder							
	Plaice	1	1			1		
	Sole							
Lophiidae	Angler	1						
Other	Cod Family Q2 Elements					3785	6934	
	Cod Family Q3 Elements					1240	5271	
	Unidentified Cod Family					13837	32573	
	Not Cod Family Q2 Elements					38		
	Not Cod Family Q3 Elements					7		
	Unidentified Fish	1427	32156					
	Unidentified Fish Cranial			23	232			
	Unidentified fish vertebrae			1114	15925			
	Unidentified Not Gadidae					18	1527	
	Total Fish	3158	35651	1280	18340	20116	49253	

Table 5.7a

A summary of the bird remains (by fragment count) in 10 faunal assemblages from Orkney and Caithness which predominately date to the Viking Age (see Table 5.1 for references)

Common Name	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Areas 1 & 2	Buckquoy	Brough of Birsay, Room 5	Saevar Howe	Skaill, Deerness	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Divers										
Great Northern Diver				5		2	1			
Red/Black-throated Diver			1							
Red-throated Diver							1			
Fulmar				3				2		
Manx Shearwater	4	1	21	11		2	2	1		
Gannet	1		14	48		9	20	40	61	
Cormorant/Shag	1		3				14	4		
Cormorant			3	2		1	10	61	19	
Shag	2	1	8	7			38	71	23	
Grey Heron			1				2			
Swan, Goose & Duck Family			1	2				5		
Swans								1		
Mute Swan										
Whooper Swan				3						
Goose								3		
Greylag Goose/Bean Goose								38	8	
Domestic/Wild Greylag Goose	1		9	13			20			
Goose		1							1	
Shelduck				4						
Mallard			11				1	3	1	
Teal								1		
Wigeon				1						
Shoveler										
Eider			1				4			
Pochard								1		
Red-breasted Merganser								2		
White-tailed Eagle							1	1		
White-tailed Eagle/Golden Eagle										
Goshawk										
Buzzard							4			
Kestrel								3		
Merlin								5		
Grouse Family		1								
Red Grouse							14			
Fowl	1	3	3	11		2	14	8	5	
Turkey										
Crane			5							
Wader										
Oystercatcher			2				1	3		
Water Rail							1			
Lapwing							2			
Plovers		2	3				1			
Plovers								2		
Golden Plover							3			
Sandpiper & Snipe Family							1			
Dunlin				1						
Knot				1					1	
Curlews										
Curlew			1				2	2		
Whimbrel										
Greenshank				1						
Snipe										
Grey Phalarope				1						
Pomarine Skua				1						
Gull Family			3	1			1	3	1	
Common Gull/Kittiwake										
Common Gull								1	1	
Herring/Lesser Black-back	2	2	3	3			32	20	9	
Herring Gull						6				
Lesser Black-backed Gull			1							
Great Black-backed/Glaucous Gull	4	1	1	3			10			
Great Black-backed Gull			2			1		19	4	
Kittiwake						1		17		
Auk Family			1			1				
Great Auk							1	1	1	
Razorbill/Guillemot	1	1					4			
Razorbill	3		3	2			7	14	4	
Guillemot	2		1	6			8	5	9	
Puffin/Black Guillemot	2									
Puffin			4	3				6	1	
Black Guillemot								1		
Little Auk	1		1	3			2	1		
Dove/Pigeon Subfamily	1					2	3			
Rock/Stock Dove		1						1		
Rock Dove			1	3						
Stock Dove		1								
Wood Pigeon										
Short-eared Owl							1			
Passerine Subfamily			3					1	1	
Small Passerines	3	1								
Thrush & Chat Family								1	3	
Blackbird/Ring Ouzel										
Redwing/Song Thrush				1						
Starling			1	2						
Crows				8						
Rook/Crow			1				8	1	1	
Carrion Crow			1							
Raven				1			6	23	1	
Unidentified Bird	66	7	71	10	19		50	106	38	12
Total Bird	95	23	185	161	19	27	290	478	193	12

Table 5.7b

A summary of the bird remains (by fragment count) in 15 faunal assemblages from Orkney, Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.1 for references)

Common Name	Brough of Birsay, Sites VII-IX Phase 3	Freswick Links, Area 9	Freswick Links, MCA	Freswick Links, NCA	St. Boniface, Phase 8	Tuquoy	Beachview Burnside Area 2 (Hand Collected)	Beachview Burnside Area 2 (Sieved)
Divers								
Great Northern Diver								
Red/Black-throated Diver								
Red-throated Diver								
Fulmar								
Manx Shearwater			5	5				
Gannet			2	4		33	25	7
Cormorant/Shag							1	1
Cormorant			7	2		16	3	
Shag			7	16		62	3	
Grey Heron								
Swan, Goose & Duck Family			1	1		30		
Swans								
Mute Swan								
Whooper Swan								
Goose								
Greylag Goose/Bean Goose					2			
Domestic/Wild Greylag Goose			10	1				
Goose						83	19	3
Shelduck								
Mallard								
Teal								
Wigeon								
Shoveler								
Eider								
Pochard								
Red-breasted Merganser								
White-tailed Eagle					3			
White-tailed Eagle/Golden Eagle								
Goshawk								
Buzzard						6		
Kestrel								1
Merlin								
Grouse Family								
Red Grouse			1		1			
Fowl			48	68	1	123	6	3
Turkey								
Crane								
Wader				2		13		4
Oystercatcher			1					
Water Rail								
Lapwing								
Plovers			3					2
Plovers								
Golden Plover								
Sandpiper & Snipe Family			1	1				
Dunlin								
Knot								
Curlews								
Curlew							1	1
Whimbrel								
Greenshank								
Snipe								
Grey Phalarope								
Pomarine Skua								
Gull Family			1	41		46		
Common Gull/Kittiwake			1	9				
Common Gull							2	
Herring/Lesser Black-back			4	8			2	
Herring Gull								
Lesser Black-backed Gull								
Great Black-backed/Glaucous Gull			2	57				
Great Black-backed Gull								
Kittiwake			1	20				
Auk Family							1	1
Great Auk								
Razorbill/Guillemot			8	8	1			4
Razorbill			6	14		18		
Guillemot			11	26	1	15	5	3
Puffin/Black Guillemot			13					
Puffin			23	1		3	1	1
Black Guillemot			1					2
Little Auk			1	1				
Dove/Pigeon Subfamily			2			13	1	
Rock/Stock Dove		1					1	11
Rock Dove								
Stock Dove								
Wood Pigeon					1			
Short-eared Owl								
Passerine Subfamily								
Small Passerines			2	7		14		8
Thrush & Chat Family								
Blackbird/Ring Ouzel								
Redwing/Song Thrush								
Starling								3
Crows								
Rook/Crow			1					
Carrion Crow								
Raven			1			11		
Unidentified Bird	33	1	167	298	1	171	10	49
Total Bird	33	2	331	590	11	657	81	104

Table 5.7b (continued)

A summary of the bird remains (by fragment count) in 15 faunal assemblages from Orkney, Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.1 for references)

Common Name	Beachview Studio Site (Hand Collected)	Beachview Studio Site (Sieved)	Sandwick, MU3 & 4 Early	Sandwick, MU2, MU 3 & 4 Middle-Late	Earl's Bu, selected LN contexts	Robert's Haven, Area A	Freswick Castle
Divers							2
Great Northern Diver	4						
Red/Black-throated Diver							
Red-throated Diver							
Fulmar							
Manx Shearwater	6					15	
Gannet	36	5					
Cormorant/Shag					1		
Cormorant	1	1				1	
Shag	3	1				1	
Grey Heron							
Swan, Goose & Duck Family	1				1		
Swans							
Mute Swan							
Whooper Swan							
Goose							
Greylag Goose/Bean Goose							
Domestic/Wild Greylag Goose							9
Goose	8	2			5	1	
Shelduck							
Mallard	1						
Teal							
Wigeon							
Shoveler							
Eider		1					
Pochard							
Red-breasted Merganser							
White-tailed Eagle							
White-tailed Eagle/Golden Eagle					1		
Goshawk							
Buzzard							
Kestrel							
Merlin							
Grouse Family							
Red Grouse							2
Fowl	6	6			17	1	42
Turkey							1
Crane							
Wader	1	1					
Oystercatcher							
Water Rail							
Lapwing							
Plovers							
Plovers							2
Golden Plover							
Sandpiper & Snipe Family							
Dunlin							
Knot							
Curlews							
Curlew							2
Whimbrel							
Greenshank							
Snipe						2	
Grey Phalarope							
Pomarine Skua							
Gull Family	1						
Common Gull/Kittiwake							
Common Gull							
Herring/Lesser Black-back	1						1
Herring Gull						2	
Lesser Black-backed Gull							
Great Black-backed/Glaucous Gull	1						
Great Black-backed Gull							
Kittiwake							
Auk Family	2						
Great Auk							
Razorbill/Guillemot							
Razorbill							
Guillemot	1	1					
Puffin/Black Guillemot					1		1
Puffin	3						
Black Guillemot							
Little Auk							
Dove/Pigeon Subfamily	2				21		3
Rock/Stock Dove	2	1					1
Rock Dove							
Stock Dove							
Wood Pigeon							
Short-eared Owl							
Passerine Subfamily							
Small Passerines	1	2					
Thrush & Chat Family							
Blackbird/Ring Ouzel							
Redwing/Song Thrush							
Starling	2	2					3
Crows					5		
Rook/Crow	3						
Carrion Crow							
Raven							
Unidentified Bird	19	20	50	154	380	40	21
Total Bird	105	43	50	154	432	63	90

Table 5.8a

A summary of the botanical remains (by 'seed' count or presence) in 10 assemblages from Orkney, Caithness and Shetland which predominately date to the Viking Age (see Table 5.2 for references)

Ecological Group	Taxon	Common Name	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Area 2	Brough of Birsay, Room 5	Jarlshof, VA Phases	Saevar Howe	Tuquoy Area J	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Driftwood and/or Imported Wood*												
	cf. Acer campestre	Field Maple							√			
	Alnus	Alder						√				
	Alnus glutinosa	Alder	√									√
	Fagus	Beech										
	Fraxinus	Ash							√			
	Fraxinus excelsior	Ash										√
	Picea	Spruce						√	√			√
	Picea abies	Spruce			√							
	Pinus	Pine							√			
	Pinus cf. sylvestris	Scots Pine										
	Pinus sylvestris	Scots Pine				√	√					√
	Pinus/Picea	Pine/Spruce	√		√							√
	Quercus	Oak	√	√	√	√	√		√			√
	Quercus suber	Cork Oak										
Cereal Grain												
	Avena	Oat	93	50	138			25	√	√	√	120
	Avena strigosa type	Bristle Oat										38
	Cerealia	Cereal	19	47								
	cf. Hordeum	Barley										
	Hordeum	Barley	89	31					√			
	Hordeum cf. vulgare	Barley			976			27				37
	Hordeum vulgare	Barley						36		√	√	
	cf. Triticum	Wheat										
	Triticum	Wheat										
	Triticum (hexaploid)	Wheat										
	Triticum aestivum	Bread Wheat										
Cereal Chaff and Straw												
	Avena Awn		75									
	Avena floret base											
	Avena sativa/strigosa Floret Base											
	Avena sativa Floret Base		1									
	Avena Glumes											
	Rachis Internode											
	Hordeum Rachis Internode		12									
	Hordeum 6-row Rachis Internode		1									
	Triticum Rachis Internode											
	Culm nodes											
	Lemma											
Other Economic Taxa												
	Linum usitatissimum	Flax	2		1			102	√	√	√	
	Vicia faba	Celtic Bean										
Arable Weeds												
	Agrostemma githago											
	Anthemis cotula											
	Aphanes arvensis											
	Capsella bursa-pastoris								√			
	Centaurea cyanus											
	Chenopodium album		2						√	√	√	
	Chenopodium album type											
	Chenopodium bonus-henricus											
	Chrysanthemum segetum											
	Euphorbia helioscopia		1						√			
	Fallopia convolvulus											
	Fumaria								√			
	Galeopsis								√			
	Galeopsis tetrahit											
	Polygonum aviculare		5					1	√	√	√	
	Polygonum aviculare type											
	Polygonum lapathifolium											
	Polygonum periscaria		1									
	Spergula arvensis			1	1			53	√	√	√	1
	cf. Stellaria media											
	Stellaria media		20	2	3			1	√	√	√	9
	Thlaspi arvense											
	Urtica urens								√	√	√	
	Veronica arvensis type											
	Veronica cf. arvensis											
Woodland or Scrub Taxa												
	Alnus/Betula		√									
	Alnus/Corylus avellana		√									
	Betula		√	√	√	√	√	√	√			√
	Coniferae											
	Corylus						√					
	Corylus avellana		√				√		√			
	Fragaria vesca											
	Juniperus							√				
	cf. Juniperus communis						√					
	Larix								√			
	Luzula cf. sylvatica											
	Luzula sylvatica											
	Prunella vulgaris											
	Rubus fruticosus		1									
	cf. Salix											
	Salix		√	√	√		√	√	√			√
	Salix/Populus					√						
	Silene dioica											
	Sorbus aucuparia							2				
	Ulex								√			

*Note that *Alnus*, *Pinus* and *Quercus* are native on mainland Scotland (and may have been locally available at Freswick and Robert's Haven).

Table 5.8a (continued)

A summary of the botanical remains (by 'seed' count or presence) in 10 assemblages from Orkney, Caithness and Shetland which predominately date to the Viking Age (see Table 5.2 for references)

Ecological Group	Taxon	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Area 2	Brough of Birsay, Room 5	Jarlshof, VA Phases	Saevar Howe	Tuquoy Area J	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Grassland Taxa											
	Centaurea nigra	2									
	Gramineae 2-4mm										
	Gramineae >4mm										
	Leontodon							√			
	Linum catharticum							√			
	Plantago lanceolata								√	√	
	Potentilla cf. erecta							√			
	Potentilla erecta								√		3
	Ranunculus acris										1
	Ranunculus acris type										
	Rhinanthus minor							√			
	Rumex acetosa										
	Trifolium cf. pratense										
	Trifolium pratense										
Heathland Taxa											
	Calluna vulgaris	√	√	√			√	√	√	√	
	Calluna vulgaris seeds										3
	Empetrum nigrum	1	1	1			4		√	√	3
	Erica							√			
	Erica cinerea							√			
	Erica tetralix	32						√			
	Juncus squarrosus						5				
	Salix repens										
	Sieglingia decumbens										
Ruderal Taxa											
	Artemisia vulgaris							√			
	Atriplex	1						√			
	Atriplex hastata/patula										1
	Brassica							√			
	cf. Diplotaxus muralis										
	Erysimum cheiranthoides										
	Galium aparine	1									
	Hyoscyamus niger										
	Lapsana communis										
	Odontites/Euphrasia							√			
	Plantago major							√			
	Plantago major/media										
	Plantago media										
	Potentilla anserina										
	Raphanus raphanistrum			2				√			1
	Rumex acetosella	5						√			
	Rumex cf. crispus			1				√			
	Rumex crispus										
	Rumex obtusifolius-type	2	1								
	Sinapis arvensis										
	Sonchus asper							√			
	Tripleurospermum maritimum							√			
	Urtica dioica							√			
Wet Ground Taxa											
	Caltha palustris										
	Carex			2			10				2
	Carex (lenticular)										
	Carex (trigonous)	14									
	Carex hostiana										
	Cirsium cf. palustre										
	Cirsium palustre										
	Cyperaceae			√				√	√	√	
	Eleocharis										
	cf. Eleocharis palustris										
	Eleocharis palustris										
	Eleocharis uniglumis										
	Equisetum										
	Eriophorum										
	Eriophorum angustifolium										
	Eriophorum vaginatum										
	Hydrocotyle vulgaris							√			
	Litorella										
	Litorella uniflora										
	Lychnis flos-cuculi							√			
	Montia fontana							√	√	√	1
	Montia fontana ssp. chondrosperma										
	Montia fontana ssp. fontana										29
	Polygonum hydropiper										
	Potamogeton							√			
	Potentilla palustris										
	Ranunculus flammula							√			2
	Sphagnum										

Table 5.8a (continued)

A summary of the botanical remains (by 'seed' count or presence) in 10 assemblages from Orkney, Caithness and Shetland which predominately date to the Viking Age (see Table 5.2 for references)

Ecological Group	Taxon	Freswick Links, SCA	Freswick Links, Area 3	Brough Road Area 2	Brough of Birsay, Room 5	Jarlshof, VA Phases	Saevar Howe	Tuquoy Area J	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2
Unclassified	**Taxa**										
	Alchemilla							√			
	Anthemis arvensis							√			
	Aphanes										
	Blysmus										
	Brassica/Sinapis								√	√	
	Bromus	1	2				2				
	Bryophyta							√			
	Carduus/Cirsium										
	Carex/Rumex										
	Caryophyllaceae	1									
	Cerastium							√			
	Chenopodiaceae	1									
	Chenopodium										2
	Compositae										
	Cruciferae			1							
	Danthonia decumbens									√	
	Ericaceae							√			
	Euphrasia										
	Galium										
	Gramineae	8	3				6	√	√	√	3
	Gramineae <2mm										
	Hedera helix										√
	Hieracium										
	Hordeum (wild)										
	Isolepis setaceus										
	Juncus							√			
	Juncus capsule										
	Labiatae?										
	Labiate A										
	Legume <4mm	1	1								
	cf. Luzula										
	Luzula										
	Luzula sylvatus										
	Myosotis							√			
	Papaver						4	√			
	Polygonaceae		1								
	cf. Polygonum										
	Polygonum										
	Potentilla						5	√			
	Ranunculus										
	Ranunculus acris/repens/bulbosus							√			
	Ranunculus repens type	1									
	Rhytidiadelphus triquetrus										
	Rosaceae										
	Rumex						7	√	√	√	9
	Rumex/Carex										
	Sagina										1
	Salvia/Stachys							√			
	Selaginella selaginoides						1	√			
	Senecio cf. aquaticus							√			
	Silene								√		
	cf. Stachys										
	cf. Trifolium										
	Trifolium							√			
	Tripleurospermum							√			
	Umbelliferae										
	Unidentified						6				
	Veronica cf. agrestis										
	cf. Vicia										
	Vicia										
	Viola							√			
Other											
	Seaweed	√		√				√	√	√	
	Fucus										√
	Peat	√	√								√
	Total	393	140	1126			297				266

Table 5.8b

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Common Name	Brough of Birsay, Sites VII-IX Phase 3	The Biggings, Period 2	Earl's Bu, selected LN contexts	Freswick Links, Area 9	Freswick Links, MCA	Freswick Links, NCA	Jarlshof, LN Phases
Driftwood and/or Imported Wood									
	cf. Acer campestre	Field Maple							
	Alnus	Alder							
	Alnus glutinosa	Alder	√			√		√	
	Fagus	Beech		√					
	Fraxinus	Ash							
	Fraxinus excelsior	Ash							
	Picea	Spruce	√	√					
	Picea abies	Spruce							
	Pinus	Pine							√
	Pinus cf. sylvestris	Scots Pine		√					
	Pinus sylvestris	Scots Pine	√	√					
	Pinus/Picea	Pine/Spruce				√	√	√	
	Quercus	Oak	√	√		√		√	√
	Quercus suber	Cork Oak		√					
Cereal Grain									
	Avena	Oat	18		2368	16	1460	398	
	Avena strigosa type	Bristle Oat							
	Cerealia	Cereal			5	17	574	41	
	cf. Hordeum	Barley		√					
	Hordeum	Barley		√	613	17	1845	480	
	Hordeum cf. vulgare	Barley	5						
	Hordeum vulgare	Barley							
	cf. Triticum	Wheat							
	Triticum	Wheat					11		
	Triticum (hexaploid)	Wheat			1				
	Triticum aestivum	Bread Wheat					17		
Cereal Chaff and Straw									
	Avena Awn							1	
	Avena floret base				3				
	Avena sativa/strigosa Floret Base				3				
	Avena sativa Floret Base				2		7	4	
	Avena Glumes				5				
	Rachis Internode								
	Hordeum Rachis Internode				1		4	1	
	Hordeum 6-row Rachis Internode				7		6		
	Triticum Rachis Internode						2	3	
	Culm nodes				4		57	3	
	Lemma								
Other Economic Taxa									
	Linum usitatissimum	Flax			8		17	2	
	Vicia faba	Celtic Bean			1		2		
Arable Weeds									
	Agrostemma githago						4	2	
	Anthemis cotula						22	2	
	Aphanes arvensis								
	Capsella bursa-pastoris								
	Centaurea cyanus						6		
	Chenopodium album						21		
	Chenopodium album type								
	Chenopodium bonus-henricus						4		
	Chrysanthemum segetum				2				
	Euphorbia helioscopia						4		
	Fallopia convolvulus						2	1	
	Fumaria				1				
	Galeopsis								
	Galeopsis tetrahit								
	Polygonum aviculare				16				
	Polygonum aviculare type								
	Polygonum lapathifolium								
	Polygonum periscaria				6		1		
	Spergula arvensis				88		12	5	
	cf. Stellaria media								
	Stellaria media		3	√	130	2	229	34	
	Thlaspi arvense								
	Urtica urens								
	Veronica arvensis type								
	Veronica cf. arvensis								
Woodland or Scrub Taxa									
	Alnus/Betula					√		√	
	Alnus/Corylus avellana								
	Betula		√	√		√	√	√	√
	Coniferae			√					
	Corylus								
	Corylus avellana		√		√		√	√	
	Fragaria vesca								
	Juniperus								
	cf. Juniperus communis								
	Larix								
	Luzula cf. sylvatica								
	Luzula sylvatica								
	Prunella vulgaris								
	Rubus fruticosus								
	cf. Salix						√		
	Salix		√			√		√	
	Salix/Populus								
	Silene dioica								
	Sorbus aucuparia								
	Ulex								

*Note that *Alnus*, *Pinus* and *Quercus* are native on mainland Scotland (and may have been locally available at Freswick and Robert's

Table 5.8b (continued)

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Brough of Birsay, Sites VII-IX Phase 3	The Biggings, Period 2	Earl's Bu, selected LN contexts	Freswick Links, Area 9	Freswick Links, MCA	Freswick Links, NCA	Jarlshof, LN Phases
Grassland Taxa								
	Centaurea nigra							
	Gramineae 2-4mm			4				
	Gramineae >4mm							
	Leontodon							
	Linum catharticum							
	Plantago lanceolata			12		2	3	
	Potentilla cf. erecta							
	Potentilla erecta		√					
	Ranunculus acris							
	Ranunculus acris type							
	Rhinanthus minor							
	Rumex acetosa			92		18	1	
	Trifolium cf. pratense							
	Trifolium pratense							
Heathland Taxa								
	Calluna vulgaris	√		√	√	√	√	
	Calluna vulgaris seeds							
	Empetrum nigrum	2		22	1	3		
	Erica							
	Erica cinerea							
	Erica tetralix							
	Juncus squarrosus							
	Salix repens			√				
	Sieglingia decumbens			1		15		
Ruderal Taxa								
	Artemisia vulgaris							
	Atriplex					57	8	
	Atriplex hastata/patula	1						
	Brassica			1		4		
	cf. Diplotaxus muralis							
	Erysimum cheiranthoides							
	Galium aparine					126		
	Hyoscyamus niger							
	Lapsana communis							
	Odontites/Euphrasia							
	Plantago major							
	Plantago major/media							
	Plantago media							
	Potentilla anserina			1				
	Raphanus raphanistrum			7		1		
	Rumex acetosella			22		270	12	
	Rumex cf. crispus							
	Rumex crispus							
	Rumex obtusifolius-type			41		262	4	
	Sinapis arvensis			1				
	Sonchus asper							
	Tripleurospermum maritimum							
	Urtica dioica							
Wet Ground Taxa								
	Caltha palustris			6				
	Carex	5	√					
	Carex (lenticular)			10	1	2		
	Carex (trigonous)			15		12		
	Carex hostiana							
	Cirsium cf. palustre							
	Cirsium palustre	1						
	Cyperaceae							
	Eleocharis			1				
	cf. Eleocharis palustris		√					
	Eleocharis palustris			13				
	Eleocharis uniglumis							
	Equisetum					6		
	Eriophorum							
	Eriophorum angustifolium							
	Eriophorum vaginatum							
	Hydrocotyle vulgaris							
	Litorella							
	Litorella uniflora							
	Lychnis flos-cuculi							
	Montia fontana							
	Montia fontana ssp. chondrosperma							
	Montia fontana ssp. fontana							
	Polygonum hydropiper					3		
	Potamogeton							
	Potentilla palustris							
	Ranunculus flammula	3		9				
	Sphagnum		√					

Table 5.8b (continued)

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Brough of Birsay, Sites VII-IX Phase 3	The Biggings, Period 2	Earl's Bu, selected LN contexts	Freswick Links, Area 9	Freswick Links, MCA	Freswick Links, NCA	Jarlshof, LN Phases
Unclassified	**Taxa**							
	Alchemilla							
	Anthemis arvensis							
	Aphanes							
	Blysmus							
	Brassica/Sinapis							
	Bromus			13		21	2	
	Bryophyta							
	Carduus/Cirsium							
	Carex/Rumex							
	Caryophyllaceae			3		2	5	
	Cerastium							
	Chenopodiaceae			7		120	15	
	Chenopodium							
	Compositae							
	Cruciferae							
	Danthonia decumbens							
	Ericaceae							
	Euphrasia							
	Galium							
	Gramineae	16				65	31	
	Gramineae <2mm			1				
	Hedera helix	√						
	Hieracium							
	Hordeum (wild)							
	Isolepis setaceus			1				
	Juncus							
	Juncus capsule			1				
	Labiatae?							
	Labiate A							
	Legume <4mm			1		32	2	
	cf. Luzula							
	Luzula			1				
	Luzula sylvatus							
	Myosotis							
	Papaver							
	Polygonaceae					8		
	cf. Polygonum							
	Polygonum							
	Potentilla							
	Ranunculus							
	Ranunculus acris/repens/bulbosus							
	Ranunculus repens type			1			1	
	Rhytidiadelphus triquetrus		√					
	Rosaceae							
	Rumex	14						
	Rumex/Carex							
	Sagina							
	Salvia/Stachys							
	Selaginella selaginoides							
	Senecio cf. aquaticus							
	Silene							
	cf. Stachys							
	cf. Trifolium							
	Trifolium							
	Tripleurospermum		√					
	Umbelliferae							
	Unidentified							
	Veronica cf. agrestis							
	cf. Vicia							
	Vicia							
	Viola		√					
Other								
	Seaweed		√		√	√	√	
	Fucus			√		√	√	
	Peat	√	√		√	√	√	
	Total	68		3551	54	5336	1061	

Table 5.8b (continued)

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Common Name	Tuquoy, Area F	Beachview Burnside Area 2	Beachview Studio Site	Sandwick, MU1	Robert's Haven, Area A	Freswick Castle
Driftwood and/or Imported Wood								
	cf. Acer campestre	Field Maple						
	Alnus	Alder	√	√				
	Alnus glutinosa	Alder			√			√
	Fagus	Beech						
	Fraxinus	Ash	√	√				
	Fraxinus excelsior	Ash			√			
	Picea	Spruce						
	Picea abies	Spruce						
	Pinus	Pine						
	Pinus cf. sylvestris	Scots Pine						
	Pinus sylvestris	Scots Pine						√*
	Pinus/Picea	Pine/Spruce	√	√	√			
	Quercus	Oak	√		√			
	Quercus suber	Cork Oak						
Cereal Grain								
	Avena	Oat	1478	2955	>c.13923	√	1020	6
	Avena strigosa type	Bristle Oat						
	Cerealia	Cereal					70	
	cf. Hordeum	Barley						
	Hordeum	Barley	1653			√	947	2
	Hordeum cf. vulgare	Barley		1577				
	Hordeum vulgare	Barley			>c.4495			
	cf. Triticum	Wheat					2	
	Triticum	Wheat						
	Triticum (hexaploid)	Wheat						
	Triticum aestivum	Bread Wheat					2	
Cereal Chaff and Straw								
	Avena Awn						5	
	Avena floret base						21	
	Avena sativa/strigosa Floret Base							
	Avena sativa Floret Base						7	
	Avena Glumes							
	Rachis Internode				519			
	Hordeum Rachis Internode						46	
	Hordeum 6-row Rachis Internode						3	
	Triticum Rachis Internode							
	Culm nodes						33	
	Lemma				3763			
Other Economic Taxa								
	Linum usitatissimum	Flax	77	43	39	√	93	
	Vicia faba	Celtic Bean						
Arable Weeds								
	Agrostemma githago							
	Anthemis cotula						63	
	Aphanes arvensis		4					
	Capsella bursa-pastoris				4			
	Centaurea cyanus							
	Chenopodium album							
	Chenopodium album type		16					
	Chenopodium bonus-henricus							
	Chrysanthemum segetum							
	Euphorbia helioscopia		1	1	2			
	Fallopia convolvulus						4	
	Fumaria				1			
	Galeopsis							
	Galeopsis tetrahit				4			
	Polygonum aviculare			8	123			
	Polygonum aviculare type		18					
	Polygonum lapathifolium						1	
	Polygonum periscaria							
	Spergula arvensis		31	25	775		168	
	cf. Stellaria media		2					
	Stellaria media		307	117	648		1336	
	Thlaspi arvense				2			
	Urtica urens							
	Veronica arvensis type			1	1			
	Veronica cf. arvensis		1					
Woodland or Scrub Taxa								
	Alnus/Betula							
	Alnus/Corylus avellana							
	Betula		√	√	√			
	Coniferae							
	Corylus			√				
	Corylus avellana		√		√			
	Fragaria vesca			1	1			
	Juniperus							
	cf. Juniperus communis							
	Larix							
	Luzula cf. sylvatica			57	50			
	Luzula sylvatica		1					
	Prunella vulgaris						1	
	Rubus fruticosus							
	cf. Salix							
	Salix		√	√	√			
	Salix/Populus							
	Silene dioica		14					
	Sorbus aucuparia			1	4			
	Ulex							

*Note that *Alnus*, *Pinus* and *Quercus* are native on mainland Scotland (and may have been locally available at Freswick and Robert's Haven

Table 5.8b (continued)

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Tuquoy, Area F	Beachview Burnside Area 2	Beachview Studio Site	Sandwick, MU1	Robert's Haven, Area A	Freswick Castle
Grassland Taxa							
	Centaurea nigra						
	Gramineae 2-4mm					50	
	Gramineae >4mm					47	
	Leontodon						
	Linum catharticum					2	
	Plantago lanceolata	8	19	127		7	
	Potentilla cf. erecta	6		7			
	Potentilla erecta						
	Ranunculus acris						
	Ranunculus acris type	5	2	13			
	Rhinanthus minor						
	Rumex acetosa					9	
	Trifolium cf. pratense	2					
	Trifolium pratense			1			
Heathland Taxa							
	Calluna vulgaris	√	√	√		√	
	Calluna vulgaris seeds	1	5				
	Empetrum nigrum	45	139	75		191	
	Erica						
	Erica cinerea						
	Erica tetralix						
	Juncus squarrosus						
	Salix repens						
	Sieglingia decumbens						
Ruderal Taxa							
	Artemisia vulgaris						
	Atriplex	18	11	600		17	
	Atriplex hastata/patula						
	Brassica					3	
	cf. Diplotaxus muralis	6					
	Erysimum cheiranthoides	5					
	Galium aparine	26	4	31		1	
	Hyoscyamus niger	2	1	3			
	Lapsana communis					1	
	Odontites/Euphrasia						
	Plantago major	2		5			
	Plantago major/media					1	
	Plantago media		1				
	Potentilla anserina						
	Raphanus raphanistrum		29	406		2	
	Rumex acetosella		1	32		5	
	Rumex cf. crispus	558	203	477			
	Rumex crispus	16		139			
	Rumex obtusifolius-type					43	
	Sinapis arvensis						
	Sonchus asper						
	Tripleurospermum maritimum	8	4	143		105	
	Urtica dioica	4		3		5	
Wet Ground Taxa							
	Caltha palustris	1	6	1			
	Carex	95	49	307			
	Carex (lenticular)					8	
	Carex (trigonous)					32	
	Carex hostiana					1	
	Cirsium cf. palustre			1			
	Cirsium palustre	5					
	Cyperaceae	8	12	10			
	Eleocharis					4	
	cf. Eleocharis palustris						
	Eleocharis palustris					2	
	Eleocharis uniglumis		9	13			
	Equisetum			√			
	Eriophorum		2				
	Eriophorum angustifolium					2	
	Eriophorum vaginatum					9	
	Hydrocotyle vulgaris	1					
	Littorella		8				
	Littorella uniflora	4		1			
	Lychnis flos-cuculi						
	Montia fontana	2		2			
	Montia fontana ssp. chondrosperma	10					
	Montia fontana ssp. fontana	2	1				
	Polygonum hydropiper						
	Potamogeton					2	
	Potentilla palustris			1			
	Ranunculus flammula	6	9	39		3	
	Sphagnum						

Table 5.8b (continued)

A summary of the botanical remains (by 'seed' count or presence) in 13 assemblages from Orkney Caithness and Shetland which predominately date to the Late Norse Period (see Table 5.2 for references)

Ecological Group	Taxon	Tuquoy, Area F	Beachview Burnside Area 2	Beachview Studio Site	Sandwick, MU1	Robert's Haven, Area A	Freswick Castle
Unclassified Taxa							
	Alchemilla						
	Anthemis arvensis						
	Aphanes		1			1	
	Blysmus			1			
	Brassica/Sinapis	20	6	487			
	Bromus					3	
	Bryophyta	√		√		√	
	Carduus/Cirsium	2					
	Carex/Rumex	28					
	Caryophyllaceae	341	24	119			
	Cerastium			2			
	Chenopodiaceae	73				447	
	Chenopodium		12	56			2
	Compositae	7	2	8		63	
	Cruciferae	2	4	12			
	Danthonia decumbens						
	Ericaceae						
	Euphrasia	1					
	Galium		2	4			
	Gramineae	118	9	14		328	
	Gramineae <2mm					68	
	Hedera helix						
	Hieracium	1					
	Hordeum (wild)					5	
	Isolepis setaceus						
	Juncus						
	Juncus capsule						
	Labiatae?		3				
	Labiate A		2				
	Legume <4mm					3	
	cf. Luzula	3		4			
	Luzula	1					
	Luzula sylvatus	2					
	Myosotis						
	Papaver						
	Polygonaceae					2	
	cf. Polygonum			2			
	Polygonum		5			3	
	Potentilla	2	10	7		4	
	Ranunculus					24	
	Ranunculus acris/repens/bulbosus						
	Ranunculus repens type					5	
	Rhytidiadelphus triquetrus						
	Rosaceae		1				
	Rumex	6		5			
	Rumex/Carex		77	59			
	Sagina						
	Salvia/Stachys						
	Selaginella selaginoides						
	Senecio cf. aquaticus						
	Silene						
	cf. Stachys			1			
	cf. Trifolium		2				
	Trifolium						
	Tripleurospermum	1					
	Umbelliferae	3		1			
	Unidentified			24			
	Veronica cf. agrestis	1					
	cf. Vicia			2			
	Vicia					1	
	Viola	3	2	7			
Other							
	Seaweed	√	√	√		√	
	Fucus					√	
	Peat		√	√		√	
	Total	5064	5463	>27606		5331	10

Table 5.9

Robert's Haven phase interpretations

Phase	Interpretation
4	Superficial and modern deposits (loose sand, topsoil, posthole fill)
3	Postmedieval (PM) middens and structures (c.16th C.)
2	?Late Norse 2 (LN2) deposits (between dated LN2 & PM strata)
1	Late Norse 2 middens and sand blows (13th-14th C.)
0	Natural

Table 5.10

Quantity of sediment excavated and sieved at Robert's Haven

Area	Phase	Soil Volume (litres)	Soil Weight (kilograms)	Shell (grams)	Bone (grams)
A	1	915.5	1059	15340.7	12251.8 0
E	4	57.5	58	505.3	28.4
E	1	844	924.7	7344.4	685.5
E	0	94	120	2.4	0.3
E	Total	995.5	1102.7	7852.1	714.2 0
B	4	59.5	67	584.5	18.4
B	3	205	224	1387	88.6
B	2	578	744.4	55098.2	274.7
B	1	89	137	311.9	124.4
B	Total	931.5	1172.4	57381.6	506.1

Table 5.11

Weight of shell and bone by period for three sites at Freswick Links: NCA, MCA and SCA (data from project archive)

Site	Period	Shell (g)*	%	Fish Bone (g)*	%	Mammal Bone (g)	%	Bird Bone (g)	%
Northern Cliff Areas (NCA)	Topsoil	17.3	*0.1*	0.8	*0.0*	1.6	*0.1*	0.0	*0*
	Late Norse 2	29522.0	*86.2*	12237.6	*91.1*	2550.4	*90.8*	140.8	*89.17*
	Hiatus	2488.6	*7.3*	476.7	*3.6*	94.3	*3.4*	7.6	*4.813*
	Late Norse &/or Viking Age	1662.4	*4.9*	509.1	*3.8*	80.3	*2.9*	8.4	*5.32*
	Late Norse, Viking Age &/or Pictish	577.0	*1.7*	201.9	*1.5*	81.0	*2.9*	1.1	*0.697*
	Natural	0.0	*0.0*	0.1	*0.0*	0.0	*0.0*	0.0	*0*
	Total	34267.3	*100.0*	13426.2	*100.0*	2807.6	*100.0*	157.9	*100*
Middle Cliff Areas (MCA)	Post-medieval &/or Late Norse	6159.9	*17.2*	779.7	*12.3*	889.7	*20.4*	16.0	*24.92*
	Late Norse	2876.5	*8.0*	546.3	*8.6*	482.9	*11.1*	10.0	*15.58*
	Late Norse?	23006.9	*64.1*	2374.1	*37.4*	1474.8	*33.8*	6.5	*10.12*
	Hiatus?	22.7	*0.1*	33.8	*0.5*	3.9	*0.1*	0.1	*0.156*
	Late Norse &/or Viking Age	3792.9	*10.6*	2601.4	*41.0*	1471.7	*33.7*	31.2	*48.6*
	Natural	56.4	*0.2*	16.3	*0.3*	43.7	*1.0*	0.4	*0.623*
	Total	35915.3	*100.0*	6351.6	*100.0*	4366.7	*100.0*	64.2	*100*
Southern Cliff Areas (SCA)	Late Norse, Viking Age &/or Pictish	2933.5	*13.3*	164.8	*18.1*	189.1	*11.0*	1.5	*9.934*
	Pictish	19179.3	*86.7*	747.8	*81.9*	1534.7	*89.0*	13.6	*90.13*
	Total	22112.8	*100.0*	912.6	*100.0*	1723.8	*100.0*	15.1	*100.1*

*Weight of shell and fish bone based on selective sorting of sieved samples. See Section 5.3.3.

Table 5.12

Freswick Links, A comparison of the shell and bone content (by weight) of 47 samples from NCA sorted by Jones' method (Jones et al. forthcoming a) and completely sorted to 4mm

							Mann-Whitney Test of Total Weight > Original Weight	
Material	Median Original Weight	Mean	Standard Deviation	Median Re-sorted Weight	Mean	Standard Deviation	Significant within the 95% Confidence Interval?	Actual Significance Level
Shell	124	234.3	22.3	303.1	386.2	320.9	yes	0.0034
Fish Bone	114	122.1	69.8	200.8	198.7	102.3	yes	0.0001
Mammal Bone	20.8	31.2	32.1	27.7	35.1	33.4	no	0.1563
Bird Bone	0.3	2	3.3	0.6	2.2	3.4	no	0.1589

Table 5.13

Relative abundance and weight of fish, mammal and bird bone in assemblages for which comparable data are available
(see Table 5.1 for references)

Assemblage	Brough Road Areas 1 & 2	Pool, Phase 7	Pool, Phase 8	Brough of Birsay, Sites VII-IX Phase 2	Brough of Birsay, Sites VII-IX Phase 3	Freswick Links, NCA	Beachview Burnside Area 2 (Hand Collected)	Beachview Burnside Area 2 (Sieved)	Beachview Studio Site (Hand Collected)	Beachview Studio Site (Sieved)	Earl's Bu, selected LN contexts	Robert's Haven, Area A
Approximate Date	Viking Age	Viking Age 1	Viking Age 2-Late Norse 1	Viking Age	Late Norse 1	Late Norse	Late Norse 1	Late Norse 1	Late Norse 1	Late Norse 1	Late Norse 2?	Late Norse 2
Proportion Sieved Sieve Size	Partial 0.85mm, 10mm	Minimal 3mm, 10mm	Minimal 3mm, 10mm	? 5mm	? 5mm	Total 4mm	Hand Collected	Total 0.895	Hand Collected	Total 0.895	Total 4mm	Total 4mm
Fragment Count Data Count (%)												
Fish	10827 (71.8)	6570 (26.9)	6394 (45.1)	51 (1.0)	41 (1.1)		2398 (60.8)	58826 (83.0)	3158 (42.0)	35651 (97.3)	20116 (43.1)	49259 (98.5)
Mammal	4069 (27)	17388 (71.2)	7577 (53.5)	5026 (98.8)	3545 (98.0)		1464 (37.1)	11973 (16.9)	4251 (56.6)	956 (2.6)	26075 (55.9)	673 (1.3)
Bird	185 (1.2)	478 (2.0)	193 (1.4)	12 (0.2)	33 (0.9)		81 (2.1)	104 (0.1)	105 (1.4)	43 (0.1)	432 (0.9)	63 (0.1)
Bone Weight (g) Data Weight (%)												
Fish						9340.5 (84.2)		1795 (25.8)			3471.1 (13.0)	11916 (97.3)
Mammal						1651.3 (14.9)		5160.5 (74.2)			23051.8 (86.5)	280.7 (2.3)
Bird						100.9 (0.9)					118.5 (0.5)	55.4 (0.5)

Table 6.1

Viking Age highly probable (***), probable (**) and possible (*) imported items

Region	Site or Sites	Wheel-made Pottery	Steatite	Antler Combs	Whetstones	Copper Alloy Sheet	Silver or Gold	Other Distinctive Metalwork	Wood	Non-metallic Ornaments	References
Orkney	Tuquoy (p)								** Timber Offcuts		Crone n.d.; Owen 1993
	Pool (p)		***	***					** Implied Structure		Hunter et al. 1990; 1993
	Brough of Birsay		***	*** Reindeer?	*		*** Coins, +	** Børre Style Mask, Pins, +	*	*** Glass, Amber, Jet	Curle 1982; Hunter & Morris 1982; Hunter 1986; Stevenson 1986; Weber 1992; 1993
	Buckquoy Settlement			*** Reindeer?	*					** Glass	Ritchie 1976-1977; Weber 1992, 1993
	Brough Road Areas 1 & 2		***	*** Reindeer?	*** Norwegian? Purple Phyllite	** ?		** Ringed Pin	*	*** Amber	Crosby & Mitchell 1987; Morris 1989; Weber 1993
	Saevar Howe		***	***	*	**	*** Perforated Coin		*	*** Glass Vessel	Hedges 1983; Weber 1993
	Earl's Bu (p)		***	***			* Gold Fragment		** Implied Mill Wheel	** Glass	Batey 1993a; Batey pers comm.
	Brough of Deerness		***				*** Coin		**? Timber Chapel		Morris & Emery 1986; Morris 1990
	Skaill, Deerness		***	*** Reindeer?	*					** Glass	Gelling 1984; Weber 1993
	Newark Bay (p)						*** 2 Coins				Brothwell 1977; Stevenson 1986
	Orkney Graves		***?	***	*	**	*** Coin, +	** Ringed Pins, Broochs, +	** Boats	*** Glass, Amber, 'Jet'	Batey 1989a; Grieg 1940; Kaland 1973; 1993b; Ritchie 1976-1977; Thorsteinsson 1968
Caithness	Freswick Links (p)			**				?			Batey 1987a; Morris et al. forthcoming a
	Caithness Graves		***	**	*			** Ringed Pins, Brooches, +	**? Boat?	*** Glass, 'Jet'	Batey 1993; Grieg 1940
Shetland	Kebister (p)								**? Timber Chapel?		Owen & Smith 1988; Owen 1993
	Jarlshof Phases I - IV		*	*** Reindeer?	*		* Ring-Money	** 2 Ringed Pins, Trefoil Brooch, +	*	** Glass, Lignite?	Fanning 1983; Graham-Campbell 1976; Hamilton 1956; Weber 1992
	Shetland Graves						* Silver Arm-Ring	** Brooches, +		** Glass	Graham-campbell 1976; Grieg 1940

Notes: "(1)" dating uncertain, see Chapter 3; "(p)" preliminary report only; "***?" provenance uncertain; "?" or "Reindeer?" material uncertain; "+" also other items

Table 6.2

Late Norse highly probable (***), probable (**) and possible (*) imported items

Region	Site or Sites	Wheel-made Pottery	Steatite	Antler Combs	Whetstones	Copper Alloy Sheet	Silver or Gold	Other Distinctive Metalwork	Wood	Non-metallic Ornament	References
Orkney	Tuquoy (p)	***						** Ringed Pin	*		Nye & Boardman n.d.; Owen 1993
	Pool (p)	***	***								Hunter et al. 1990; 1993
	Westness Settlement (p)	?	***	**	*	?	*				Kaland 1973; 1993
	Brough of Birsay	***	***	**	*	**	*** coins, +	** Pin, Gilt Buckle	*		Curle 1982; Hunter 1986; Stevenson 1986
	Beachview Burnside Area 2		***	**					*		Morris forthcoming a
	Beachview Studio Site		***	**	*** Shetland Phylite?	**	*		*	***? Ivory	Crosby & Mitchell 1987; Morris forthcoming a
	Kirkwall	***	***?		*						McGavin 1982
	Brough of Deerness	***	***		*	**	*				Morris & Emery 1986
	Earl's Bu (p)	***	***	***	*		*			***? Amber	Batey 1993a; Batey pers comm.
Caithness	Robert's Haven (p)	***						** Tinned Spoon			This Study; Morris et al. 1994
	Bishop's Palace,	***		**		**					Talbot 1970; 1973a; 1973b
	Freswick Links (p)	***	***	**	*	**	*** Coin	** Urnes Style Strap End, Ringed Pin(s), +		***? Amber	Batey 1987a; Morris et al. forthcoming a
	Freswick Castle	***									Batey et al. 1984
Shetland	Sandwick (p)	***	*** Hardanger Bakestones	*** Reindeer?	*	**		** Rosette, Key			Bigelow 1984; 1985; 1989; Weber 1992
	Underhoull (1)		*		*						Small 1966; Bigelow 1987
	Kebister (p)	***									Owen & Smith 1988
	The Biggings (p)	***	*** Hardanger Bakestones						*** Timber Floor, +		Crawford 1985; 1991; Dickson n.d.; Weber 1992
	Jarlshof Phases V-VII & Medieval	***	*** Hardanger Bakestones	*** Reindeer?	*	**	*** Coin	** Harness Mount, Key	*	** Glass	Hamilton 1956; Bigelow 1989; Stevenson 1966; 1986; Weber 1992

Notes: "(1)" dating uncertain, see Chapter 3; "(p)" preliminary report only; "***?" provenance uncertain; "?" or "Reindeer?" material uncertain; "+" also other items

Table 6.3

Late Norse 1 highly probable (***), probable (**) and possible (*) imported items

Region	Site or Sites	Wheel-made Pottery	Steatite	Antler Combs	Whetstones	Copper Alloy Sheet	Silver or Gold	Other Distinctive Metalwork	Wood	Non-metalic Ornament	References
Orkney	Tuquoy (p)							** Ringed Pin			Owen 1993
	Brough of Birsay	*** (1 Sherd)	***	**	*		*** Coins	** Pin, Gilt Buckle	*		Curle 1982; Hunter 1986; Stevenson 1986
	Beachview Burnside Area 2		***	**					*		Morris forthcoming a
	Beachview Studio Site		***	**	*** Shetland Phylite?	**	*		*	***? Ivory	Crosby & Mitchell 1987; Morris forthcoming a
	Brough of Deerness		***		*		*				Morris & Emery 1986
Shetland	Sandwick (p)	***	*	***	*?	**		**? Key			Bigelow 1984; 1985; 1989; Weber 1992
	Underhoull (1)		*		*						Small 1966; Bigelow 1987
	Jarlshof Phases V & VI		*	*** Reindeer?	*	**	*** Coin			** Glass	Hamilton 1956; Stevenson 1966; 1986; Weber 1992

Notes: "(1)" dating uncertain, see Chapter 3; "(p)" preliminary report only; "***?" provenance uncertain; "?" or "Reindeer?" material uncertain; "+" also other items

Table 6.4

Late Norse 2 highly probable (***), probable (**) and possible (*) imported items

Region	Site or Sites	Wheel-made Pottery	Steatite	Antler Combs	Whetstones	Copper Alloy Sheet	Silver or Gold	Other Distinctive Metalwork	Wood	Non-metalic Ornament	References
Orkney	Tuquoy (p)	***									Owen 1993
	Brough of Birsay	***									Curle 1982; Hunter 1986
	Kirkwall	***	***?		*						McGavin 1982
	Brough of Deerness	***				**					Morris 1986
Caithness	Robert's Haven (p)	***						** Tinned Spoon			This Study; Morris et al. 1994
	Freswick Links (p)	***		**	*	**	*** Coin	** Annular Brooch			Batey 1987a; Morris et al. forthcoming a
	Freswick Castle	***									Batey et al. 1984
Shetland	Sandwick (p)	***	*	***	*?	**		** Rosette			Bigelow 1984; 1985; 1989; Weber 1992
	Kebister (p)	***									Owen & Smith 1988
	Jarlshof Phases V-VII & Medieval	***	*	***	*	**		** Harness Mount	*	** Glass	Hamilton 1956; Bigelow 1989; Stevenson 1966; 1986; Weber 1992

Notes: "(1)" dating uncertain, see Chapter 3; "(p)" preliminary report only; "**?" provenance uncertain; "?" or "Reindeer?" material uncertain; "+" also other items

Table 6.5

Probable imported pottery recovered in Orkney, Caithness and Shetland

Region	Site	Description	Sherd Count	Suggested Date	References
Orkney					
	Pool	Dutch Grey Ware	2	12th-13th century	Hunter et al. 1990:188; pers comm.
	Tuquoy	Scottish East Coast White Gritty Ware	7	12th-13th century	Murray n.d.; Owen 1993:329
		Unidentified Scottish Wares	5	13th-14th century	Murray n.d.; Owen 1993:329
		Low Countries Grey Ware	4	14th century (mid-late)	Murray n.d.; Owen 1993:329
		Aardenburg Ware	1	13th century (late)	Murray n.d.; Owen 1993:329
		Low Countries Red Ware	5	14th century (late)	Murray n.d.; Owen 1993:329
		Scarborough Ware	3	13th-14th century	Murray n.d.; Owen 1993:329
		Unidentified Yorkshire Wares	6	12th-14th century	Murray n.d.; Owen 1993:329
	Brough of Birsay	Scarborough Ware	4		Curle 1982:89-90, 121
		Wheel-made with Green Glaze	1	Phase 3, 11th century or later	Hunter 1986:185
	Earl's Bu	Wheel-made, Glazed		Late Norse	Batey & Harry pers comm.
	Kirkwall	White Gritty Ware, Probably Scottish	43	13th-14th centuries	MacAskill 1982:407, 413
		Red Sandy Wares, Probably Scottish	c.300	13th-14th centuries	MacAskill 1982:407, 413
		Scarborough Ware	11	13th-14th centuries	MacAskill 1982:407, 413
Caithness					
	Robert's Haven	Scottish East Coast White Gritty Ware	1	14th century	Will 1995
		Scottish East Coast White Gritty Type Ware	2	13th-14th centuries	Will 1995
		Scottish East Coast White Gritty Type Ware	1	14th-15th century	Will 1995
		Scottish Medieval Redwares	1	14th century	Will 1995
	Freswick Links	Scottish East Coast Gritty Wares		12th-14th centuries	Gaimster & Batey forthcoming
		Aberdeen Local Wares		12th-14th centuries	Gaimster & Batey forthcoming
	Freswick Castle	Scarborough Ware	1	13th-14th centuries	Batey et al. 1984:107, 115; Mills 1984:MF188-MF191
		Low Countries Red Ware	7	14th century	Batey et al. 1984:107, 115; Mills 1984:MF188-MF191
	Bishop's Palace, Scrabster	Pottery		12th-13th centuries	Talbot 1973a:21-22
Shetland					
	Sandwick	Rhenish Blue-grey Ware (Paffrath?)	9	12th century	Bigelow 1984:101
		Scarborough Ware	3	13th-14th century	Bigelow 1984:101
		Grimston Ware	2	13th-14th century	Bigelow 1984:101
	The Biggings	Stoneware from Saxony/North Hesse		14th-15th century	Crawford 1985:153-158
		Yorkshire Pottery		13th-14th century	Crawford 1985:153-158
		Dutchware		13th-14th century	Crawford 1985:153-158
	Kebister			14th century	Owen & Smith 1988:17
	Jarlshof	Wheel-made, Medieval	63	13th century type & 14th-15th century type	Bigelow 1984:100; 1989:188; Hamilton 1956:183, 193
	Total		**c.482**		

Table 6.6

Viking Age and Late Norse hoards of Orkney, Caithness and Shetland*

Region	Hoard	Coins	Silver or Gold Objects	Suggested Date	Period	References
Orkney	Broch of Burgar		√ (Gold Arm-Rings)	?	Viking Age	Graham-Campbell 1985:242-4; 1993:184
	Stenness		√ (Gold Finger-Rings)	1000s?	Viking Age 2-Late Norse 1	Graham-Campbell 1976:124,130; 1993:182, 184
	Ring of Brodgar		√ (Ring-Money)	?	Viking Age 2-Late Norse 1	Graham-Campbell 1976:126, 128-130; 1993:184
	Skaill	√	√	c.950	Viking Age 2	Graham-Campbell 1976:128; 1993:184
	Burray	√	√	c.1000	Viking Age 2-Late Norse 1	Graham-Campbell 1976:128; 1993:184
	Caldale	√	√	c.1035	Viking Age 2-Late Norse 1	Graham-Campbell 1976:128; 1993:184
Caithness	Kirk o' Banks		√ (Ring-Money)	?	Viking Age 2-Late Norse 1	Graham-Campbell 1976:126, 128-130; 1993:184
	Braemore	√		early 1300s	Late Norse 2	Stewart 1973:139
	Ladykirk	√		c.1320	Late Norse 2	Stewart 1973:135
Shetland	Garthbanks/ Quendale	√	√	c.1000	Viking Age 2-Late Norse 1	Graham-Campbell 1976:128; 1993:184
	Dunrossness Manse	√	√	c.1065?	Viking Age 2-Late Norse 1	Graham-Campbell 1976:128; 1993:184

*Graham-Campbell's (1995) new survey of Scottish Viking Age hoards, published after this table was compiled, provides more comprehensive information.

Table 6.7

Single finds of silver and gold from Orkney, Caithness and Shetland which date to the Viking Age or Late Norse Period*

Region	Site	Context	Coins or Objects	Suggested Date	Period	References
Orkney	Oxtro Brough	?	Brooch Fragment? (Hacksilver?)		Viking Age	Graham-Campbell 1984:299-300; 1993:184
	Saevar Howe	Settlement	Burgred (Pierced)	866-868	Viking Age 1-2	Batey & Morris 1983:93-94; Stevenson 1986:340
	Earl's Bu	Settlement	Gold Fragment		Viking Age	Batey & Harrey pers comm.
	Brough of Birsay	Settlement	2 Fragmentary Silver Items (Hacksilver?)		Viking Age 2	Hunter 1986:186-187
	Buckquoy	Grave	Eadmund	Reign 940-946	Viking Age 2	Stevenson 1986:340
	Newark, Deerness	Chapel	Eadred	Reign 946-955	Viking Age 2	Stevenson 1986:340
	Newark, Deerness	Chapel	Anlaf Sihtricsson	York Reign 941-952	Viking Age 2	Smyth 1978:10; Stevenson 1986:340
	Brough of Deerness	Chapel	Eadgar	Reign 959-75	Viking Age 2	Morris 1986:356; Stevenson 1986:340
	Brough of Birsay	Settlement	Eadgar	Reign 959-75	Viking Age 2	Stevenson 1986:340
	Westness	Settlement	Silver Ring, Gold Fragment		Late Norse?	Graham-Campbell 1993:184; Kaland 1973:99; Morris 1985:221
	Beachview Studio Site	Settlement	Hacksilver?		Late Norse 1	Batey et al. forthcoming b
	Earl's Bu	Settlement	Gold Fragment		Late Norse	Batey & Harrey pers comm.
	Brough of Birsay	Settlement	Aethalraed II	Reign 978-1016	Viking Age 2-Late Norse 1	Stevenson 1986:340
	Brough of Birsay	Settlement	Hacksilver		Viking Age 2-Late Norse 1	Graham-Campbell 1993:184; Hunter 1986:142-143, 187
	Brough of Birsay	Settlement	Aethalraed II	c.1009-1010	Viking Age 2-Late Norse 1	Stevenson 1986:340
	Brough of Birsay	Graveyard	Olav Kyrre	c.1080	Viking Age 2-Late Norse 1	Stevenson 1986:340
Caithness	Freswick Links	Settlement	Gold Fragment, Hacksilver		Late Norse	Graham-Campbell 1993:184; Morris et al. 1992:94, 97
	Freswick Links	Settlement	Henry III	Reign 1258-1272	Late Norse 2	Batey 1987a:107
Shetland	Jarlshof	?	Silver Pin		Viking Age?	Bruce 1907:28; Graham-Campbell 1993:184
	Oxna	?	Gold Arm-Ring		Viking Age?	Graham-Campbell 1976:131; 1980:62; 1993:184; Grieg 1940:141-142
	Clibberswick, Unst	Grave	Silver Arm-Ring	Late 800s?	Viking Age 1-2	Graham-Campbell 1976:126, 131; 1993:179, 184
	Gulberwick	?	Silver 'Thistle-Brooch'	900s	Viking Age 2	Graham-Campbell 1976:121, 131; 1993:180, 184
	Marrister, Whalsay	?	Gold Finger-Ring		Viking Age 2-Late Norse 1 or 2	Graham-Campbell 1976:124, 131; 1993:182, 184; Grieg 1940:141
	Jarlshof	Settlement	Ring-Money		Viking Age 2-Late Norse 1	Graham-Campbell 1976:126, 131; Hamilton 1956:152
	Jarlshof	Settlement	Aethalraed II	Reign 978-1016	Viking Age 2-Late Norse 1	Stevenson 1966:xx; 1986:340
	Sumburgh	Graveyard	Olav Kyrre	Reign 1066-1093	Viking Age 2-Late Norse 1	Dolley 1967-1968; Tait 1995:12
	Upper Scalloway	?	Henry II	Minted 1180-1189	Late Norse 1	Tait 1995:12
	Buness, Baltasound	?	Håkon V	Reign 1299-1319	Late Norse 2	Tait 1995:13

*Graham-Campbell's (1995) new survey of Scottish Viking Age hoards, published after this table was compiled, provides more comprehensive information.

Table 7.1

Correspondence analysis of the weight of shell and bone in samples from Freswick Links: Contribution to inertia of the column variables

Variable	Axis 1	Axis 2	Axis 3
Shell	0.206	0.009	0.000
Fish Bone	0.670	0.177	0.013
Mammal Bone	0.114	0.813	0.001
Bird Bone	0.011	0.001	0.987

Table 7.2

Correspondence analysis of the weight of shell and bone in samples from Freswick Links: Representation of the column variables by the Correspondence analysis

Variable	Axis 1	Axis 2	Axis 3
Shell	0.974	0.026	0.000
Fish Bone	0.861	0.138	0.001
Mammal Bone	0.188	0.812	0.000
Bird Bone	0.111	0.005	0.885

Table 7.3

Correspondence analysis of the weight of shell and bone in samples from Robert's Haven: Contribution to inertia of the column variables

Variable	Axis 1	Axis 2	Axis 3
Shell	0.133	0.008	0.000
Fish Bone	0.865	0.004	0.001
Mammal Bone	0.000	0.937	0.053
Bird Bone	0.001	0.051	0.946

Table 7.4

Correspondence analysis of the weight of shell and bone in samples from Robert's Haven: Representation of the column variables by the Correspondence analysis

Variable	Axis 1	Axis 2	Axis 3
Shell	0.996	0.004	0.000
Fish Bone	0.100	0.000	0.000
Mammal Bone	0.004	0.987	0.009
Bird Bone	0.060	0.248	0.693

Table 7.5

Intra-Site variability in the fragmentation of mammal bone at Freswick Links (data from Gidney forthcoming)
(lower index indicates greater fragmentation)

Northern Cliff Areas	Area 4 Fragmentation Index	Area 6 Fragmentation Index	Area 5 Fragmentation Index	Area 10 Fragmentation Index	Combined Fragmentation Index
	0.78	0.36	0.52	0.16	0.67
Middle Cliff Areas	Area 7 Fragmentation Index	Area 8 Fragmentation Index			
	0.8	0.78			
Southern Cliff Areas	Area 11 Fragmentation Index	Area 12 Fragmentation Index	Area 13 Fragmentation Index	Area 14 Fragmentation Index	Combined Fragmentation Index
	0.22	0.34	0.24	0.17	0.24
Area 3	Cattle Fragmentation Index	Sheep Fragmentation Index			
	0.8	0.28			
Area 9	Cattle Fragmentation Index	Sheep Fragmentation Index	Pig Fragmentation Index		
	0.58	0.25	1.36		

Table 7.6

Correspondence analysis of the weight of shell and bone in samples from Earl's Bu: Contribution to inertia of the column variables (see Appendix 7.2 for data & references)

Variable	Axis 1	Axis 2	Axis 3
Shell	0.000	0.423	0.576
Fish Bone	0.866	0.000	0.001
Mammal Bone	0.134	0.001	0.004
Bird Bone	0.001	0.576	0.419

Table 7.7

Correspondence analysis of the weight of shell and bone in samples from Earl's Bu: Representation of the column variables by the analysis (see Appendix 7.2 for data & references)

Variable	Axis 1	Axis 2	Axis 3
Shell	0.000	0.518	0.482
Fish Bone	0.100	0.000	0.000
Mammal Bone	0.998	0.000	0.001
Bird Bone	0.002	0.666	0.331

Table 8.1

Relative representation of skeletal elements in cured gadoid fish from medieval Schleswig and a 16th century Dutch shipwreck

Anatomical Location	Element	Schleswig 11th-14th century Cod (Heinrich 1987:92)	Scheurrak SO1 Wreck Barrel 1 16th entury Cod (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 1 16th entury Gadoid (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 2 16th entury Cod (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 2 16th entury Torsk (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 2 16th entury Cod/Torsk (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 2 16th entury Ling (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 2 16th entury Gadoid (Brinkhuizen 1994:198, 201)	Scheurrak SO1 Wreck Barrel 3 16th entury Cod (Brinkhuizen pers comm.)	Scheurrak SO1 Wreck Barrel 3 16th entury Torsk (Brinkhuizen pers comm.)	Scheurrak SO1 Wreck Barrel 3 16th entury Ling (Brinkhuizen pers comm.)	Scheurrak SO1 Wreck Barrel 3 16th entury Gadoid (Brinkhuizen pers comm.)
Cranial	Articular	7											
	Basioccipital										1		
	Ceratohyal	5											
	Dentary	20											
	Ectopterygoid	2											
	Epiotic									1	1		
	Exoccipital	1									2		
	Frontal	3											
	Infrapharyngeal				4						1		
	Interopercular	1											
	Lacrimal	5											
	Maxilla	5											
	Opercular	12	1										
	Opisthotic										2		
	Palatine	1											
	Parietal										1		
	Premaxilla	2											
	Preopercular	10											
	Prootic	1											
	Pterotic	1											
	Symplectic	2											
	Subopercular	15											
	Supraoccipital		2		2					10	2	1	
Appendicular	Posttemporal	1	4		31	3				258	27	2	
	Supracleithrum		10		42	6				279	42	11	
	Cleithrum	62	17		63	18		6		317	50	12	
	Postcleithrum	18		18					53				311
	Scapula			14					63				350
	Coracoid			16					56				342
	Basipterygium	1		20					32				282
Tail	Abdominal Vertebra	797					144						292
	Caudal Vertebra	84	160						1417				4872
	Vertebrae	5											

Table 8.2
Number of elements in each vertebral group for principal gadoid taxa

Common Name	Taxon	Number of Specimens Examined	First Vertebra	Abdominal Vertebrae Group 1	Abdominal Vertebrae Group 2 (range)	Abdominal Vertebrae Group 3 (range)	Caudal Vertebrae Group 1 (range)	Caudal Vertebrae Group 2 (range)	Penultimate Vertebra	Ultimate Vertebra	Total Abdominal Vertebrae	Total Caudal Vertebrae
Cod	*Gadus morhua*	5	1	4	5 (4-6)	8 (7-8)	14 (13-16)	17 (15-19)	1	1	18	33
Pollack	*Pollachius pollachius*	1	1	4	5	11	15	15	1	1	21	32
Saith	*Pollachius virens*	5	1	4	5 (4-5)	13 (12-15)	13 (12-14)	16 (15-17)	1	1	23	31
Haddock	*Melanogrammus aeglefinus*	1	1	3	4	11	16	16	1	1	19	34
Whiting	*Merlangius merlangus*	1	1	4	5	9	14	19	1	1	19	35
Torsk	*Brosme brosme*	1	1	4	5	10	29	14	1	1	20	45
Three-bearded rockling	*Gaidropsarus vulgaris*	1	1	2	4	8	22	10	1	1	15	34
Ling	*Molva molva*	4	1	4	5 (4-6)	15 (14-16)	25 (24-25)	12 (11-12)	1	1	25	39
Cod, Saith, Pollack	*Gadus/Pollachius*	11	1	4	5	8-13	13-15	15-17	1	1	18-23	30-34
"Other Gadidae"	*Merlangius merlangus, Brosme brosme, Gaidropsarus vulgaris*	4	1	2-4	4-5	8-10	14-29	10-19	1	1	15-20	26-50

Table 8.3

Robert's Haven Area A: Abundance, by fragment count, of the principal fish taxa from the >4mm sample fraction (with a summary of other fish remains)

Common Name	Taxon	Category 1, elements identified to species (%)	Category 2, vertebrae	Category 3, elements identified to family	Unidentified Cod Family, other elements & fragments	Totals
Hake	*Merluccius merluccius*	2 (0.1)	11			13
	?Merluccius merluccius		1			1
Cod Family	Gadidae	650 (22.2)	893	4982	32573	39098
Cod, Saith or Pollack	*Gadus/Pollachius*	15 (0.5)	4682	6*		4703
Cod	*Gadus morhua*	817 (27.9)	372*	83*		1272
	?Gadus morhua	163 (5.6)	53*	58*		274
Saith or Pollack	*Pollachius*	53 (1.8)	53*	10*		116
Pollack	*Pollachius pollachius*	65 (2.2)	13*			78
	?Pollachius pollachius	23 (0.8)	7*	7*		37
Saith	*Pollachius virens*	721 (24.6)	126*	74*		921
	?Pollachius virens	105 (3.6)	28*	17*		150
Cod, Saith & Pollack	*Total Gadus/Pollachius*	*1962 (67.0)*	*5334*	*255**		*7551*
Haddock	*Melanogrammus aeglefinus*	27 (0.9)	203			230
	?Melanogrammus aeglefinus	6 (0.2)	6	1*		13
Whiting	*Merlangius merlangus*	2 (0.1)	1			3
	?Merlangius merlangus	2 (0.1)	2			4
Torsk	*Brosme brosme*	5 (0.2)	41	2*		48
	?Brosme brosme	3 (0.1)				3
Rockling	*Antonogadus/Ciliata/Gaidropsarus*		19			19
Ling	*Molva cf. molva*	253 (8.6)	416	28*		697
	?Molva cf. molva	17 (0.6)	7	3*		27
Total Cod & Hake Family	Total >4mm Gadidae & Merlucciidae	2929 (100)	6934	5271	32573	47707
Summary of Minor Taxa	Total >4mm not Gadidae or Merlucciidae					1527
	Total >4mm fish					**49234**
<4mm Summary (see Table 8.4)	*Total <4mm Gadidae & Merlucciidae***	*145*	*1827*	*110*		*2082*
	*Total <4mm not Gadidae or Merlucciidae***					*598*
	Total <4mm Fish**					**2680**
	Grand Total fish					**51914**

*only culturally modified specimens identified to genus or species.
**only dentaries, premaxillae, otoliths and vertebrae sorted from <4mm sample fraction.

Table 8.4

Robert's Haven Area A: Gadidae and Merlucciidae bones sorted from both >4mm and <4mm sample fractions

Common Name	Taxon	Dentaries >4mm	%	Dentaries <4mm	%	Total Dentaries	%	Premaxillae >4mm	%	Premaxillae <4mm	%	Total Premaxillae	%	Vertebrae >4mm	%	Vertebrae <4mm	%	Total Vertebrae	%
Hake	*Merluccius merluccius*							1	0.3			1	0.2	11	0.2			11	0.1
	?Merluccius merluccius													1	0.0			1	0.0
Cod Family	Gadidae	108	25.6	20	37.7	128	26.9	82	22.2	27	29.3	109	23.6	893	12.9	822	45.0	1715	19.6
Cod, Saith or Pollack	*Gadus/Pollachius*							2	0.5	4	4.3	6	1.3	4682		850		5532	
Cod	*Gadus morhua*	112	26.5	5	9.4	117	24.6	104	28.1	5	5.4	109	23.6	372		3		375	
	?Gadus morhua	35	8.3	3	5.7	38	8.0	29	7.8	6	6.5	35	7.6	53		7		60	
Saith or Pollack	*Pollachius*	6	1.4	5	9.4	11	2.3	6	1.6	17	18.5	23	5.0	53		38		91	
Pollack	*Pollachius pollachius*	9	2.1			9	1.9	6	1.6		0.0	6	1.3	13				13	
	?Pollachius pollachius	2	0.5			2	0.4	3	0.8	1	1.1	4	0.9	7				7	
Saith	*Pollachius virens*	102	24.2	12	22.6	114	24.0	81	21.9	19	20.7	100	21.6	126				126	
	?Pollachius virens	12	2.8	6	11.3	18	3.8	8	2.2	9	9.8	17	3.7	28		4		32	
Cod, Saith & Pollach	*Total Gadus/Pollachius*	*278*	65.9	*31*	58.5	*309*	65.1	*239*	64.6	*61*	66.3	*300*	64.9	*5334*	76.9	*902*	49.4	*6236*	71.2
Haddock	*Melanogrammus aeglefinus*							2	0.5			2	0.4	203	2.9	15	0.8	218	2.5
	?Melanogrammus aeglefinus	2	0.5			2	0.4							6	0.1	6	0.3	12	0.1
Whiting	*Merlangius merlangus*													1	0.0			1	0.0
	?Merlangius merlangus													2	0.0			2	0.0
Torsk	*Brosme brosme*							1	0.3			1	0.2	41	0.6			41	0.5
Rockling	*Antonogadus/Ciliata/Gaidropsarus*			1	1.9	1	0.2			1	1.1	1	0.2	19	0.3	29	1.6	48	0.5
	?Antonogadus/Ciliata/Gaidropsarus															29	1.6	27	0.3
Ling	*Molva cf. molva*	31	7.3	1	1.9	32	6.7	36	9.7	2	2.2	38	8.2	416	6.0	22	1.2	438	5.0
	?Molva cf. molva	3	0.7			3	0.6	9	2.4	1	1.1	10	2.2	7	0.1	2	0.1	9	0.1
Total Cod and Hake Family	Gadidae & Merlucciidae	422	100.0	53	100.0	475	100.0	370	100.0	92	100.0	462	100.0	6934	100.0	1827	100.0	8759	100.0

Table 8.5

Robert's Haven Area A: Fire altered Gadidae and Merlucciidae elements (>4mm sample fraction)

Common Name	Category 1 *9 elements* count (%)	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Cod Family	54 (32.9)	68	39		161
Cod, Saith or Pollack	1 (0.6)	5			6
Cod	42 (25.6)	14	7		63
Saith or Pollack	1 (0.6)	4			5
Pollack		2			2
Saith	18 (11.0)	5	1		24
Haddock		6			6
Ling	47 (28.7)	6	9		62
Hake	1 (0.6)				1
Unidentified Cod & Hake Family				1654	1654
Totals	164	110	56	1654	1984

Table 8.6

Robert's Haven Area A: Fire altered Gadidae and Merlucciidae elements (>4mm & <4mm sample fractions)

Common Name	Dentaries >4mm	Dentaries <4mm	Dentaries total	Premaxillae >4mm	Premaxillae <4mm	Premaxillae total	Vertebrae >4mm	Vertebrae <4mm	Vertebrae total	Totals
Hake				1						
Cod Family	8	2	10	16	5	21	68	15	83	114
Cod, Saith or Pollack							5	7	12	12
Cod	9	2	11	8	2	10	15	6	21	42
Saith or Pollack		1	1		3	3	4	6	10	14
Pollack							2		2	2
Saith	6	4	10	1	2	3	5		5	18
Haddock							11	4	15	15
Ling	22		22	10	2	12	6		6	40
Totals	45	9	54	36	14	49	116	38	154	257

Table 8.7

Robert's Haven Area A: Crushed Gadidae and Merlucciidae bones (>4mm sample fraction)

Common Name	Category 1 *9 elements*	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Hake		1			1
Cod Family		117			117
Cod, Saith or Pollack		27			27
Cod	1	33			34
Saith or Pollack		20			20
Pollack					
Saith		13			13
Haddock		12			12
Ling		14			14
Rockling		1			1
Unidentified Cod & Hake Family				27	27
Totals	1	238		27	266

Table 8.8

Robert's Haven Area A: Partially digested Gadidae and Merlucciidae elements (>4mm sample fraction)

Common Name	Category 1 *9 elements*	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Cod Family	16	19	10		45
Cod	3		4		7
Saith or Pollack	1	5	1		7
Saith	4	1	1		6
Haddock		1			1
Ling		3			3
Unidentified Cod & Hake Family				34	34
Totals	24	29	16	34	103

Table 8.9

Robert's Haven Area A: Gadidae and Merlucciidae elements with tooth impressions (>4mm sample fraction)

Common Name	Category 1 *9 elements*	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Cod Family	5	1	4	2	12
Cod, Saith or Pollack		2			2
Cod	16	5	3		24
Saith or Pollack	1	1			2
Pollack	2				2
Saith	2	3	1		6
Ling	5	3	6		14
Unidentified Cod & Hake Family				2	2
Totals	31	15	14	4	64

Table 8.10

Robert's Haven Area A: Relative abundance of Q1 elements for the most common taxa (>4mm sample fraction)

		CRANIAL							"APPENDICULAR"		
Common Name	Taxon	Articular	Dentary	Maxilla	Premaxilla	Quadrate	Parasphenoid (x2)	Vomer (x2)	Posttemporal	Cleithrum	Totals
Cod Family	Gadidae	117	108	74	82	59	35 (70)	34 (68)	50	91	650
Cod, Saith or Pollack	*Gadus/Pollachius*			1	2			6 (12)	2	4	15
Cod	*Gadus morhua*	87	112	117	104	96	98 (196)	93 (186)	82	28	817
	?Gadus morhua	12	35	8	29	13	13 (26)	8 (16)	25	20	163
Saith	*Pollacius virens*	96	102	91	81	100	50 (100)	54 (108)	93	54	721
	?Pollacius virens	15	12	17	8	2	25 (50)	6 (12)	12	8	105
Saith or Pollack	*Other Pollacius*	14	17	18	15	27	11 (22)	17 (34)	15	7	141
Cod, Saith & Pollack	Total Gadus/Pollachius	*224*	*278*	*252*	*239*	*238*	*197 (394)*	*184 (368)*	*229*	*121*	*1962*
Ling	*Molva cf. molva*	32	31	33	36	30	21 (42)	16 (32)	29	25	253
	?Molva cf. molva		3	3	9				1	1	17
Other Cod or Hake Family	Other Gadidae or Merlucciidae	4	2	4	4	3	5 (10)	2 (4)	6	17	47
Total Cod & Hake Family	Total Gadidae & Merlucciidae	**377**	**422**	**366**	**370**	**330**	**258 (516)**	**236 (472)**	**315**	**255**	**2929**

Table 8.11

Robert's Haven Area A: Rank order of Gadidae & Merlucciidae cranial and appendicular elements (Q1 and Q3 elements combined, >4mm sample fraction)

Rank	Element	Count	(Left/Right/?)
1	**2 x Parasphenoid [÷2]**	**516**	**[258]**
2	**2 x Vomer [÷2]**	**472**	**[236]**
3	**Dentary**	**422**	**(195/222/5)**
4	2 x Frontal [÷2]	402	[201]
5	**Articular**	**377**	**(188/189)**
6	2 x Basioccipital [÷2]	374	[187]
7	**Premaxilla**	**370**	**(221/147/2)**
8	**Maxilla**	**366**	**(181/185)**
9	**Quadrate**	**330**	**(146/184)**
10	Ceratohyal	325	(148/174/3)
11	**Posttemporal**	**315**	**(153/162)**
12	Hyomandibular	311	(162/149)
13	Opisthotic	299	(146/153)
14	Ectopterygoid	275	(122/153)
15	Palatine	273	**(146/126)**
16	Pterotic	272	(133/139)
17	**Cleithrum**	**255**	**(126/129)**
18	Sphenotic	252	(113/138)
19	Prefrontal	230	(102/128)
20	2 x Ethmoid [÷2]	218	[109]
21	Otolith	217	(106/71/40)
22	Symplectic	210	(100/110)
23	Preopercular	203	(104/99)
24	Exoccipital	202	(87/115)
25	2 x Supraoccipital [÷2]	202	[101]
26	Epihyal	196	(85/111)
27	Supracleithrum	189	(103/85/1)
28	Opercular	180	(93/87)
29	Prootic	157	(86/71)
30	Interopercular	151	(77/73/1)
31	2 x Urohyal [÷2]	150	[75]
32	Lacrimal	142	(73/69)
33	Lower Hypohyal	142	(74/68)
34	Scapula	115	(70/44/1)
35	Interhyal	99	99
36	Upper Hypohyal	66	(27/34/4)
37	2 x Basibranchial [÷2]	62	[31]
38	Coracoid	31	31
39	Basipterygium	30	30
	Total		8200

Notes: **Bold** = quantification category 1
Underline = 'appendicular' element

Table 8.12

Retention and loss of gadoid supracleithra using a 4mm sieve

Taxon	Total Fish Length (mm)	Recovery
Gadus morhua	950	retained
Gadus morhua	820	retained
Gadus morhua	820	retained
Gadus morhua	620	retained
Gadus morhua	560	retained
Gadus morhua	510	lost (just)
Gadus morhua	300	lost
Pollachius virens	1050	retained
Pollachius virens	920	retained
Pollachius virens	650	retained
Pollachius virens	580	retained (just)
Pollachius virens	460	lost
Pollachius virens	400	lost
Pollachius virens	300	lost
Molva molva	760	retained (just)
Molva molva	655	lost
Molva molva	620	lost
Molva molva	500	lost

Table 8.13

Robert's Haven Area A: Gadidae vertebrae, see Section 8.3.2 for key to abbreviations (>4mm & <4mm sample fractions)

		Vertebral Groups								Undifferentiated			
Common Name	Taxon	FV	AV1	AV2	AV3	CV1	CV2	PUV	UV	AV	CV	V	Total
Cod Family	Gadidae	28	104	24	233	409	176	25	7	60	301	348	1715
Cod, Saith & Pollack	*Gadus/Pollachius*	123	511	541	1714	1725	1386	30	22	19	131	34	6236
Haddock	*Melanogrammus aeglefinus*	3	5	35	61	90	16			1	7		218
	?Melanogrammus aeglefinus				5	1	3				2	1	12
Ling	*Molva cf. molva*	13	33	36	87	190	56	1	4	6	8	4	438
	?Molva cf. molva	2	1	1	2		1		1			1	9
Other Cod Family	Other Gadidae	1	17	23	30	40	6			1	1		119
Total Cod Family	**Total Gadidae**	**170**	**671**	**660**	**2132**	**2455**	**1644**	**56**	**34**	**87**	**450**	**388**	**8747**

Table 8.14

Robert's Haven Area A: Gadidae vertebrae and two cranial elements (divided by the number per fish) (>4mm & <4mm sample fractions)

Common Name	Dentaries left/right/?	Premaxillae left/right/?	First Vertebra	Abdominal Vertebrae Group 1*	Abdominal Vertebrae Group 2*	Abdominal Vertebrae Group 3*	Caudal Vertebrae Group 1*	Caudal Vertebrae Group 2*	Penultimate Vertebra	Ultimate Vertebra
Cod Family	60/68	66/40/3	28	26 to 52	5 to 6	16 to 29	14 to 32	9 to 18	25	7
Cod, Saith & Pollack	144/165	186/114	123	128	108	132 to 214	115 to 133	82 to 92	30	22
Haddock	1/1	2/0	3	2	9	6	6	1		
Ling	14/16/5	24/24	15	9	7	6	8	5	1	5
Other Cod Family Taxa	0/1	1/1	1	4 to 9	5 to 6	3 to 4	1 to 3	<1 to 1		
Total Cod Family	219/251/5	279/179/3	170	169 to 200	134 to 136	163 to 259	144 to 182	97 to 117	56	34

*÷ approximate No. per fish

Table 8.15

Robert's Haven Area A:
Number of bones per group of articulated vertebrae

Number of Articulations	Number of Vertebrae per Articulation
1	9
1	10
1	15
2	8
3	11
3	12
7	7
8	6
13	5
28	4
51	3
56	2

Table 8.16
Robert's Haven Area A:
Category 1 cut marks (hook or tongue removal)

Common Name	Element	Fragment Count Left	Fragment Count Right
Cod Family	dentary		1
Cod	maxilla	1	
Cod	premaxilla	1	
Saith	maxilla	1	
Ling	premaxilla	1	
Total Cod Family		4	1

Table 8.17
Robert's Haven Area A:
Category 2 cut marks (tongue or 'cheek' removal, gutting)

Taxon	Element	Fragment Count Left	Fragment Count Right
Cod	ceratoyal	1	
Cod	ceratoyal		1
Cod	interhyal		1
Ling	interhyal		1
Total Gadidae		1	3

Table 8.18

Robert's Haven Area A: Category 3 cut marks (decapitation)

Common Name	Element	Fragment Count Left	Right	Midline
Cod Family	posttemporal		1	
Cod Family	supracleithrum	1	1	
Cod Family	cleithrum	1		
Cod Family	exoccipital		1	
Cod Family	basioccipital			3
Cod Family	abdominal vertebrae group 1			4
Cod	posttemporal	2	7	
Cod	supracleithrum	4	4	
Cod	cleithrum	4	6	
Cod	first vertebra			6
Saith or Pollack	abdominal vertebrae group 1			1
Pollack	posttemporal		2	
Pollack	abdominal vertebrae group 1			1
Saith	posttemporal		3	
Saith	supracleithrum	3	2	
Saith	cleithrum	2	4	
Saith	first vertebra			3
Saith	abdominal vertebrae group 1			1
Ling	supraoccipital			1
Ling	posttemporal		1	
Ling	supracleithrum	3	1	
Ling	cleithrum	2		
Ling	first vertebra			2
Ling	abdominal vertebrae group 1			1
Total Cod Family		22	33	23

Table 8.19

Robert's Haven Area A:
Category 4 cut marks (gutting)

Common Name	Element	Number
Cod	abdominal vertebrae group 2	1
Saith	abdominal vertebrae group 3	1
Ling	abdominal vertebrae group 3	2
Total Cod Family		4

Table 8.20

Robert's Haven Area A:
Category 5 cut marks (axial splitting of fish)

Common Name	Element	Number
Cod Family	abdominal vertebrae	1
Cod Family	abdominal vertebrae group 2	1
Cod, Saith, Pollack	abdominal vertebrae group 3	2
Cod	abdominal vertebrae group 1	1
Cod	abdominal vertebrae group 2	3
Cod	abdominal vertebrae group 3	25
Cod	caudal vertebrae group 1	36
Cod	caudal vertebrae group 2	1
Saith or Pollack	abdominal vertebrae group 2	1
Saith or Pollack	caudal vertebrae group 1	1
Pollack	abdominal vertebrae group 3	1
Pollack	caudal vertebrae group 1	2
Saith	abdominal vertebrae group 3	4
Saith	caudal vertebrae group 1	6
Saith	caudal vertebrae group 2	3
Ling	first vertebra	1
Ling	abdominal vertebrae group 1	2
Ling	abdominal vertebrae group 3	3
Ling	caudal vertebrae group 1	3
Total Cod Family		97

Table 8.21

Robert's Haven Area A:
Category 6 cut marks (severing the vertebral column)

Common Name	Element	Number
Hake	abdominal vertebrae group 3	1
Cod	abdominal vertebrae group 3	4
Cod	caudal vertebrae group 1	8
Saith or Pollack	caudal vertebrae group 1	1
Pollack	abdominal vertebrae group 3	1
Saith	abdominal vertebrae group 3	1
Saith	caudal vertebrae group 1	1
Saith	caudal vertebrae group 2	2
Ling	abdominal vertebrae group 3	2
Ling	caudal vertebrae group 1	5
Ling	caudal vertebrae group 1 or 2	1
Total Cod and Hake Family		27

Table 8.22a

Earl's Bu: Abundance, by fragment count, of principal fish taxa from the >4mm sample fraction (with a summary of other fish remains)

Common Name	Taxon	Category 1, 9 elements identified to species	%	Category 2, vertebrae	Category 3, 30 elements identified to family	Unidentified Cod Family, other elements & fragments	Totals
Hake	*Merluccius merluccius*	4	0.3	7			11
Cod Family	Gadidae	407	32.3	480	1327	14819	17033
Cod, Saith or Pollack	*Gadus/Pollachius*	2	0.2	2322			2324
Cod	*Gadus morhua*	400	31.7	23*	3*		426
	?Gadus morhua	93	7.4	20*	2*		115
Pollack	*?Pollachius pollachius*	1	0.1				1
Saith	*Pollachius virens*	39	3.1	2*			41
	?Pollachius virens	3	0.2	1*			4
Cod, Saith & Pollack	*Total Gadus/Pollachius*	*538*	*42.7*	*2848*	*5**		*3391*
Haddock	*Melanogrammus aeglefinus*	268	21.3	995	4*		1267
	?Melanogrammus aeglefinus	14	1.1	8	1*		23
Whiting	*Merlangius merlangus*	3	0.2				3
	?Merlangius merlangus	1	0.1	6			7
Five-bearded Rockling	*Ciliata mustela*		0.0	1			1
Three-bearded Rockling	*Gaidropsarus vulgaris*		0.0	1			1
Ling	*Molva cf. molva*	20	1.6	152	2*		174
	?Molva cf. molva	6	0.5	6			12
Total >4mm Cod & Hake Family	Total >4mm Gadidae & Merlucciidae	1261	100.0	4024	1339	14819	21443
Summary of Minor Taxa (see Table 8.22b)	Total >4mm not Gadidae or Merlucciidae	7		50	10	20	87
	Total >4mm fish	**1268**		**4074**	**1349**	**14839**	**21530**
<4mm Summary (see Table 8.23)	*Total <4mm Gadidae & Merlucciidae***	*7*		*585*			*592*
	*Total <4mm not Gadidae or Merlucciidae***	*4*		*168*		*7*	*179*
	Total <4mm fish*	***11***		***753***		***7***	***771***
	Grand Total Fish						**22301**

*Only culturally modified specimens identified to genus or species.
**Only dentaries, premaxillae, otoliths and vertebrae sorted from <4mm sample fraction.

Table 8.22b

Earl's Bu: Abundance, by fragment count, of minor taxa from the >4mm sample fraction (with a summary of major taxa)

Common Name	**Taxon**	**Category 1,** 9 elements identified to species	%	**Category 2,** vertebrae	%	**Category 3,** 30 elements	**Unidentified,** other elements & fragments	**Totals**
Shark, Skate & Ray Orders	Pleurotremata/Hypotremata			1	<0.1			1
Spurdog	*?Squalus acanthias*			1	<0.1			1
Thornback Ray	*Raja clavata*						2	2
Salmon Family	Salmonidae	1	0.1	16	0.4	1		18
Eel	*Anguilla anguilla*	4	0.3	17	0.4	5		26
Conger Eel	*Conger conger*			1	<0.1			1
Gurnard Family	Triglidae			3	0.1	2	1	6
Red Gurnard	*Aspitrigla cuculus*			1	<0.1			1
	?Aspitrigla cuculus			1	<0.1			1
Sea Scorpion	*Taurulus bubalis*	1	0.1					1
Flatfish Order	Heterosomata					1		1
Turbot Family	Scophthalmidae			1	<0.1			1
Halibut Family	Pleuronectidae			3	0.1			3
Plaice	*Pleuronectes platessa*	1	0.1	1	<0.1			2
	?Pleuronectes platessa			2	<0.1			2
Unidentified not Cod or Hake Family	Unidentified not Gadidae or Merlucciidae			2	<0.1	1	17	20
Total not Cod or Hake Family	Total not Gadidae or Merlucciidae	7	0.6	50	1.2	10	20	87
Summary of Principal Taxa (see Table 8.22a)	Total >4mm Gadidae & Merlucciidae	1261	99.4	4024	98.8	1339	14819	21443
	Total >4mm Fish	1268	100.0	4074	100.0	1349	14839	21530

Table 8.23

Earl's Bu: Elements recovered from both >4mm and <4mm sample fractions

Name	Taxon	Dentaries >4mm	%	Dentaries <4mm	%	Total Dentaries	%	Premaxillae >4mm	%	Premaxillae <4mm	%	Premaxillae Total	%	Vertebrae >4mm	%	Vertebrae <4mm	%	Total Vertebrae	%
Hake	*Merluccius merluccius*							3	1.8			3	1.8	7	0.2			7	0.1
Cod family	Gadidae	35	29.7	3	42.9	38	30.4	45	27.6			45	26.3	480	11.6	151	16.4	631	12.5
Cod, Saith or Pollack	*Gadus/Pollachius*													2322	56.3	324	35.2	2646	52.4
Cod	*Gadus morhua*	47	39.8			47	37.6	59	36.2			59	34.5	23		1		24	
	?Gadus morhua	6	5.1			6	4.8	22	13.5	1	12.5	23	13.5	20		7		27	
Saith	*Pollachius virens*	10	8.5			10	8.0	8	4.9	1	12.5	9	5.3	2		1		3	
	?Pollachius virens							2	1.2			2	1.2	1		1		2	
	Total Gadus/Pollachius	63	53.4			63	50.4	91	55.8	2	25.0	93	54.4	2368	57.4	334	36.3	2702	53.6
Haddock	*Melanogrammus aeglefinus*	14	11.9	2	28.6	16	12.8	14	8.6			14	8.2	995	24.1	89	9.7	1084	21.5
	?Melanogrammus aeglefinus	1	0.8			1	0.8	3	1.8			3	1.8	8	0.2			8	0.2
Whiting	*Merlangius merlangus*	1	0.8			1	0.8	1	0.6			1	0.6						
	?Merlangius merlangus													6	0.1			6	0.1
Rockling	*Antonogadus/Ciliata/Gaidropsarus*															5	0.5	5	0.1
Five-bearded Rockling	*?Ciliata mustela*													1	0.0	2	0.2	3	0.1
Three-bearded Rockling	*?Gaidropsarus vulgaris*													1	0.0			1	0.0
Ling	*Molva cf. molva*							5	3.1			5	2.9	152	3.7	4	0.4	156	3.1
	?Molva cf. molva							1	0.6			1	0.6	6	0.1			6	0.1
Total Cod & Hake Family	Total Gadidae & Merlucciidae	114	96.6	5	71.4	119	95.2	163	100.0	2	25.0	165	96.5	4024	97.6	585	63.5	4609	91.4
Shark, Skate & Ray Orders	Pleurotremata/Hypotremata													1	0.0			1	0.0
Spurdog	*Squalus acanthias*															12	1.3	12	0.2
	?Squalus acanthias													1	0.0			1	0.0
Atlantic Herring	*Clupea harengus*															4	0.4	4	0.1
	?Clupea harengus															2	0.2	2	0.0
Salmon Family	Salmonidae													16	0.4	6	0.7	22	0.4
Eel	*Anguilla anguilla*	1	0.8	1	14.3	2	1.6			3	37.5	3	1.8	17	0.4	118	12.8	135	2.7
Conger Eel	*Conger conger*													1	0.0			1	0.0
Atlantic Horse-mackerel	*Trachurus trachurus*															1	0.1	1	0.0
Atlantic Mackerel	*Scomber scombrus*															1	0.1	1	0.0
Dragonet	*Callionymus*															1	0.1	1	0.0
	?Callionymus															1	0.1	1	0.0
Butterfish	*Pholis gunnellus*															4	0.4	4	0.1
	?Pholis gunnellus															5	0.5	5	0.1
Gurnard Family	Triglidae													3	0.1	1	0.1	4	0.1
Red Gurnard	*Aspitrigla cuculus*													1	0.0			1	0.0
	?Aspitrigla cuculus													1	0.0			1	0.0
Sea Scorpion	*Taurulus bubalis*	1	0.8			1	0.8												
Flatfish Order	Heterosomata															2	0.2	2	0.0
Turbot Family	Scophthalmidae													1	0.0			1	0.0
Halibut Family	Pleuronectidae													3	0.1	5	0.5	8	0.2
Plaice	*Pleuronectes platessa*													1	0.0			1	0.0
	?Pleuronectes platessa													2	0.0			2	0.0
Unidentified not Cod or Hake Family	Unidentified not Gadidae or Merlucciidae													2	0.0	5	0.5	7	0.1
Total not Cod or Hake Family	Total not Gadidae or Merlucciidae	2	1.7	1	14.3	3	2.4			3	37.5	3	1.8	50	1.2	168	18.2	218	4.3
	Totals	118	100.0	7	100.0	125	100.0	163	100.0	8	100.0	171	100.0	4124	100.0	921	100.0	5045	100.0

Table 8.24

Earl's Bu: Relative abundance of Q1 elements for the most common taxa
(>4mm sample fraction)

		CRANIAL							"APPENDICULAR"		
Common Name	Taxon	Articular	Dentary	Maxilla	Premaxilla	Quadrate	Parasphenoid (x2)	Vomer (x2)	Posttemporal	Cleithrum	Totals
Cod Family	Gadidae	71	35	39	45	63	25 (50)	16 (32)	21	92	407
Cod, Saith or Pollack	*Gadus/Pollachius*					1				1	2
Cod	*Gadus morhua*	20	47	58	59	47	53 (106)	61 (122)	45	10	400
	?Gadus morhua	10	6		22	14	4 (8)	1 (2)	13	23	93
Saith	*Pollacius virens*	4	10	1	8	3	4 (8)	2 (4)	4	3	39
	?Pollacius virens	1			2						3
Saith or Pollack	*Other Pollacius*									1	1
Cod, Saith & Pollack	*Total Gadus/Pollachius*	*35*	*63*	*59*	*91*	*65*	*61 (122)*	*64 (128)*	*62*	*38*	*538*
Haddock	*Melanogrammus aeglefinus*	31	14	22	14	20	10 (20)	20 (40)	49	88	268
	?Melanogrammus aeglefinus		1		3	7		1 (2)		2	14
Ling	*Molva cf. molva*	3		2	5	3	1 (2)	1 (2)		5	20
	?Molva cf. molva			1	1		1 (2)			3	6
Other Cod or Hake Family	Other Gadidae or Merlucciidae		1		4	1		1 (2)	1		8
Total Cod & Hake Family	Total Gadidae & Merlucciidae	**140**	**114**	**123**	**163**	**159**	**98 (196)**	**103 (206)**	**133**	**228**	**1261**
Total Excluding Haddock	*Total Excluding Melanogrammus*	***109***	***99***	***101***	***146***	***132***	***88 (176)***	***82 (164)***	***84***	***138***	***979***

Table 8.25

Earl's Bu: Rank order of Gadidae and Merlucciidae cranial and appendicular elements (Q1 and Q3 elements combined, >4mm sample fraction)

Rank	Element	Count	(Left/Right/?)
1	**Cleithrum**	**228**	**(102/126)**
2	**2 x Vomer [÷2]**	**206**	**[103]**
3	**2 x Parasphenoid [÷2]**	**196**	**[98]**
4	**Premaxilla**	**163**	**(79/84)**
5	**Quadrate**	**159**	**(94/65)**
6	**Articular**	**140**	**(68/72)**
7	2 x Basioccipital [÷2]	136	[68]
8	Ceratohyal	134	(62/72)
9	**Posttemporal**	**133**	**(71/62)**
10	**Maxilla**	**123**	**(61/61/1)**
11	**Dentary**	**114**	**(61/52/1)**
12	Supracleithrum	113	(52/59/2)
13	Pterotic	93	(44/49)
14	Hyomandibular	88	(41/47)
15	Sphenotic	70	(33/36/1)
16	2 x Ethmoid [÷2]	66	[33]
17	Opercular	65	(38/27)
18	2 x Frontal [÷2]	62	[31]
19	Symplectic	57	(26/31)
20	2 x Supraoccipital [÷2]	52	[26]
21	Palatine	51	(28/23)
22	Prefrontal	49	(22/27)
23	Preopercular	47	(19/26/2)
24	Ectopterygoid	46	(25/21)
25	Exoccipital	45	(25/20)
26	Interopercular	43	(27/16)
27	Scapula	43	(1/1/41)
28	Opisthotic	42	(19/23)
29	Epihyal	39	(19/20)
30	Lower Hypohyal	35	(15/20)
31	2 x Urohyal [÷2]	34	[17]
32	Interhyal	24	24
33	Lacrimal	21	(11/10)
34	Upper Hypohyal	20	(12/8)
35	Basipterygium	13	13
36	Prootic	13	(6/7)
37	2 x Basibranchial [÷2]	12	[6]
38	Coracoid	7	7
39	Otolith	0	0
	Total		2600

Notes: Bold = quantification category 1
underline = 'appendicular' element

Table 8.26

Rank order of Gadidae and Merlucciidae cranial and appendicular elements excluding haddock (Q1 and Q3 elements combined, >4mm sample fraction)

Rank	Element	Count	(Left/Right/?)
1	**2 x Parasphenoid [÷2]**	**176**	**[88]**
2	**2 x Vomer [÷2]**	**164**	**[82]**
3	**Premaxilla**	**146**	**(72/74)**
4	**Cleithrum**	**138**	**(64/74)**
5	2 x Basioccipital [÷2]	136	[68]
6	Ceratohyal	134	(62/72)
7	**Quadrate**	**132**	**(81/51)**
8	**Articular**	**109**	**(57/52)**
9	Supracleithrum	108	(50/56/2)
10	**Maxilla**	**101**	**(53/47/1)**
11	**Dentary**	**99**	**(53/45/1)**
12	Pterotic	93	(44/49)
13	Hyomandibular	88	(41/47)
14	**Posttemporal**	**84**	**(52/32)**
15	Sphenotic	70	(33/36/1)
16	2 x Ethmoid [÷2]	66	[33]
17	Opercular	65	(38/27)
18	2 x Frontal [÷2]	62	[31]
19	Symplectic	57	(26/31)
20	2 x Supraoccipital [÷2]	52	[26]
21	Palatine	51	(28/23)
22	Prefrontal	49	(22/27)
23	Preopercular	47	(19/26/2)
24	Ectopterygoid	46	(25/21)
25	Exoccipital	45	(25/20)
26	Interopercular	43	(27/16)
27	Scapula	43	(1/1/41)
28	Opisthotic	42	(19/23)
29	Epihyal	39	(19/20)
30	Lower Hypohyal	35	(15/20)
31	2 x Urohyal [÷2]	34	[17]
32	Interhyal	24	24
33	Lacrimal	21	(11/10)
34	Upper Hypohyal	20	(12/8)
35	Basipterygium	13	13
36	Prootic	13	(6/7)
37	2 x Basibranchial [÷2]	12	[6]
38	Coracoid	7	7
39	Otolith	0	0
	Total		2313

Notes: Bold = quantification category 1
underline = 'appendicular' element

Table 8.27

Earl's Bu: Gadidae vertebrae, see Section 8.3.2 for key to abbreviations
(>4mm & <4mm sample fractions)

		Vertebral Groups								Undifferentiated			
Common Name	Taxon	FV	AV1	AV2	AV3	CV1	CV2	PUV	UV	AV	CV	V	Total
Cod Family	Gadidae	18	117	11	80	96	47	4	3	36	210	9	631
Cod, Saith & Pollack	*Gadus/Pollachius*	29	189	294	447	894	657	23	11	16	131	11	2702
Haddock	*Melanogrammus aeglefinus*	19	77	114	214	323	266	7	2	3	58	1	1084
	?Melanogrammus aeglefinus	3	2	2	1								8
Ling	*Molva cf. molva*	1	13	6	29	63	26	2	1	7	7	1	156
	?Molva cf. molva						5		1				6
Other Cod Family	Other Gadidae		2	3	2	5	2			1			15
Total Cod Family	**Total Gadidae**	**70**	**400**	**430**	**773**	**1381**	**1003**	**36**	**18**	**63**	**406**	**22**	**4602**

Table 8.28

Earl's Bu: Gadidae vertebrae and two cranial elements divided by the number per fish
(>4mm & <4mm sample fractions)

Common Name	Dentaries left/right/?	Premaxillae left/right/?	First Vertebra	Abdominal Vertebrae Group 1*	Abdominal Vertebrae Group 2*	Abdominal Vertebrae Group 3*	Caudal Vertebrae Group 1*	Caudal Vertebrae Group 2*	Penultimate Vertebra	Ultimate Vertebra
Cod Family	17/20/1	21/24	18	29 to 59	2 to 3	5 to 10	3 to 7	3 to 5	4	3
Cod, Saith & Pollack	36/27	47/46	29	47	59	34 to 56	60 to 69	39 to 44	23	11
Haddock	9/7	7/10	22	26	29	20	20	17	7	2
Ling		4/2	1	3	1	2	3	3	2	2
Other Cod Family Taxa	0/1	1/0		1	1	<1	<1	<1		
Total Cod Family	62/55/1	80/82	70	106 to 136	92 to 93	61 to 88	86 to 99	62 to 69	36	18

*÷ approximate No. per fish

Table 8.29

Earl's Bu: Cut marks

Cut Mark Category	Common Name	Element	Number
1 (hook or tongue removal)			
	None		
2 (tongue or 'cheek' removal, gutting)			
	None		
3 (decapitation)			
	Cod Family	supracleithrum	3
	Cod	supracleithrum	1
	Cod Family	cleithrum	1
	Cod, Saith or Pollack	cleithrum	1
	Cod	posttemporal	2
	Cod	cleithrum	6
	Cod	first vertebra	1
	Haddock	posttemporal	1
	Haddock	supracleithrum	2
	Haddock	cleithrum	6
	Ling	supracleithrum	1
4 (gutting)			
	None		
5 (axial splitting of fish)			
	Saith	abdominal vertebrae group 3	1
6 (severing the vertebral column)			
	Cod	abdominal vertebrae group 3	1
	Cod	caudal vertebrae group 1	1
	Hadock	caudal vertebrae group 1	2
	Ling	abdominal vertebrac group 3	1
Other			
	Cod Family	abdominal vertebra	1
	Cod	caudal vertebrae group 1	1
	Haddock	cleithrum	1
Total			34

Table 8.30

Earl's Bu: Fire altered fish specimens (>4mm sample fraction)

Common Name	Category 1 *9 elements*	%	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Cod Family	34	56.7	35	8		77
Cod, Saith or Pollack			9			9
Cod	13	21.7	32	2		47
Saith	2	3.3	2			4
Haddock	6	10.0	21	1		28
Whiting	1	1.7				1
Ling	4	6.7	2			6
Unidentified Cod & Hake Family					1065	1065
Totals	60	100.0	101	11	1065	1237

Table 8.31

Earl's Bu: Crushed, partially digested and tooth marked fish specimens (>4mm sample fraction)

Common Name	Category 1 *9 elements*	Category 2 *vertebrae*	Category 3 *30 elements*	Other	Totals
Crushed					
Haddock		1			1
Unidentified Cod & Hake Family				2	2
Eel		1			1
Gurnard Family		2			2
Red Gurnard		1			1
Total Crushed		5		2	7
Partially Digested					
Cod Family	4	10	3		17
Cod	2	3	1		6
Haddock	2	1	2		5
Unidentified Cod & Hake Family				8	8
Total Partially Digested	8	14	6	8	36
Tooth Marked					
Cod Family	2				2
Cod	2	2			4
Haddock	1				1
Ling			1		1
Unidentified Cod & Hake Family				1	1
Total Tooth Marked	5	2	1	1	9
Total	13	21	7	11	52

Table 8.32

Cut marks recorded on gadoid bones from Viking Age and Late Norse sites in Orkney and Caithness (see Table 5.1 for references)

Site		Brough Road Areas 1 & 2	Saevar Howe	Skaill	Pool Phase 7	Pool Phase 8	Freswick	Quoygrew	St. Boniface	Tuquoy	Beachview	Earl's Bu	Robert's Haven Area A
Period		Viking Age	Viking Age	Viking Age	Viking Age 1	Viking Age 2/ Late Norse 1	Pictish-Late Norse*	Late Norse	Late Norse	Late Norse	Late Norse 1	Late Norse 2?	Late Norse 2
Number of cut bones		44	?	?	55	29	41**	?	?	132	13	34	215
Cut Mark Category	Element												
Category 1 (tongue or hook removal)	articular					√		√		√			
	dentary	√	√		√	√			√	√			√
	maxilla		√		√	√		√	√	√			√
	palatine				√								
	premaxilla	√	√		√	√				√			√
	quadrate									√			
	vomer		√		√				√				
Category 2 (gut, tongue or cheek removal)	branchiostegal ray	√	√		√	√			√	√	√		
	ceratohyal			√	√	√				√			√
	interhyal												√
Category 3 (decapitation)	supraoccipital			√						√			√
	posttemporal	√	√	√	√	√	√	√	√	√	√	√	√
	supracleithrum	√	√		√	√	√	√	√	√	√	√	√
	cleithrum	√			√	√	√	√		√	√	√	√
	postcleithrum						√			√		√	
	exoccipital												√
	basioccipital	√				√	√	√					√
	first vertebrae											√	√
	anterior abd. vertebrae					√							√
(category 3 or 5)	first vertebra	√			√		√						
(category 3 or 6)	abdominal vertebrae					√							
Category 4 (gutting)	abdominal vertebrae												√
(category 4?)	abdominal vertebrae		√										
Category 5 (axial splitting along or through vertebrae)	first vertebra												√
	abdominal vertebrae		√		√					√		√	√
	caudal vertebrae												√
	vertebrae							√	√				
(category 5 or 3)	first vertebra	√			√		√						
(category 5 or 6)	caudal vertebrae	√			√		√	√					
(category 5 or 6)	vertebrae					√				√			
Category 6 (severing vertebral column)	abdominal vertebrae											√(2 specimens)	√(9 specimens)
	caudal vertebrae											√(3 specimens)	√(18 specimens)
(category 6 or 3)	abdominal vertebrae					√(1 specimen)							
(category 6 or 5)	caudal vertebrae	√			√(2 specimens)		√(1 specimen)	√(1 specimen)					
(category 6 or 5)	vertebrae					√				√ (3 or more specimens)			
Other					√					√		√	

* Majority of Freswick material is probably Late Norse

** Only dentaries, cleithra, premaxillae and otoliths were comprehensively sorted from Freswick samples

Plate 2.1. Detail from the fair copy of the Military Survey of Scotland 1747-1755 showing cultivated land (indicated by dashed lines) at Freswick and Duncansby (*Dungsbay*), Caithness, prior to modern agricultural improvements (by kind permission of the British Library).

Plate 5.1. Wheel chamber of the Viking Age mill at Earl's Bu, Orkney (excavated by C. Batey & C. Morris). Late Norse middens filled the structure after it went out of use.

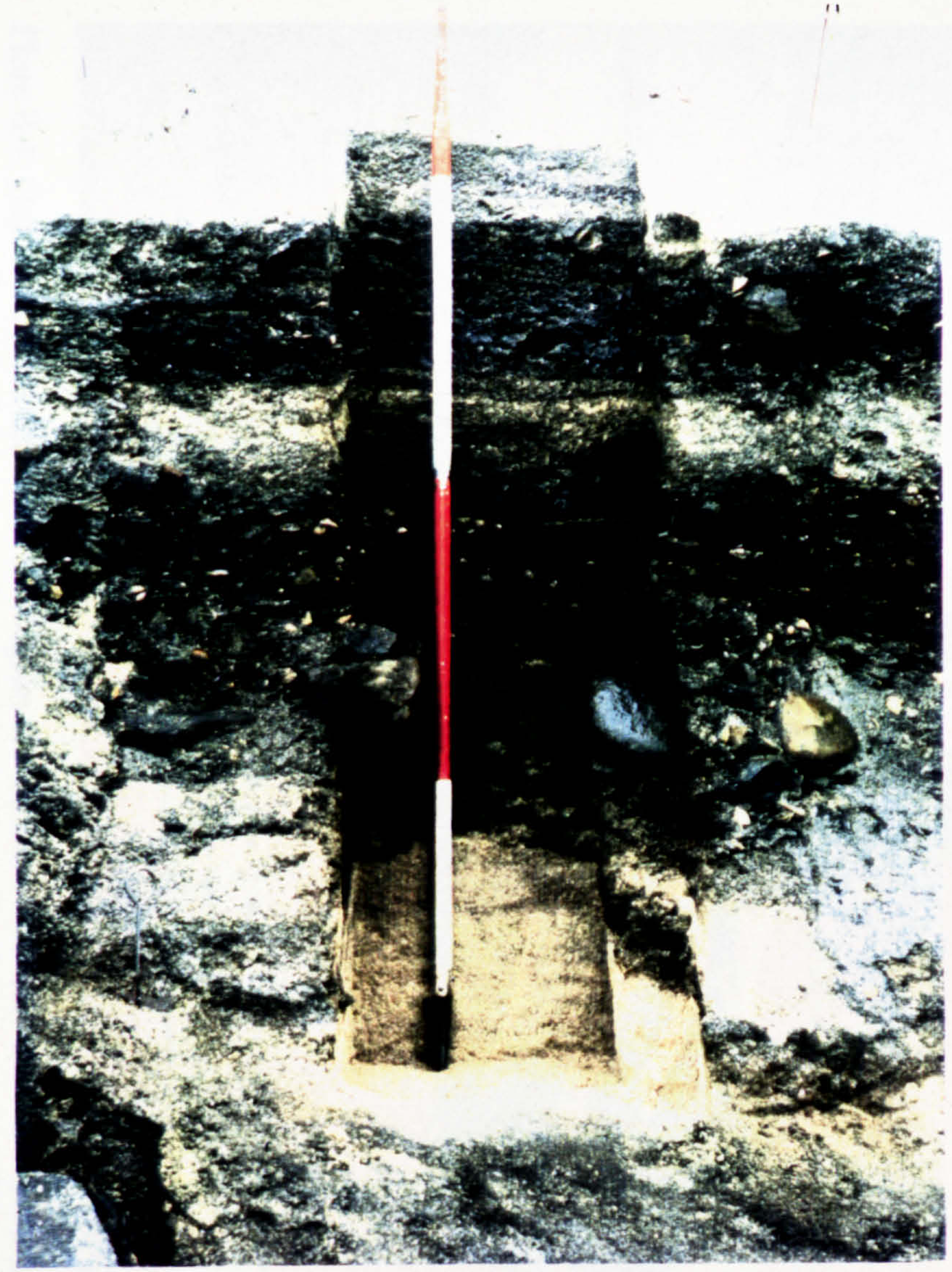


Plate 5.2. Sample Column C from Area A at Robert's Haven.

Plate 8.1. One variety of modern Norwegian stockfish. Note that caudal vertebrae and appendicular elements such as cleithra remain in the processed fish.

Plate 8.2. Stockfish drying at Stø, Andoya, Norway in 1993 (courtesy of Paul Buckland).

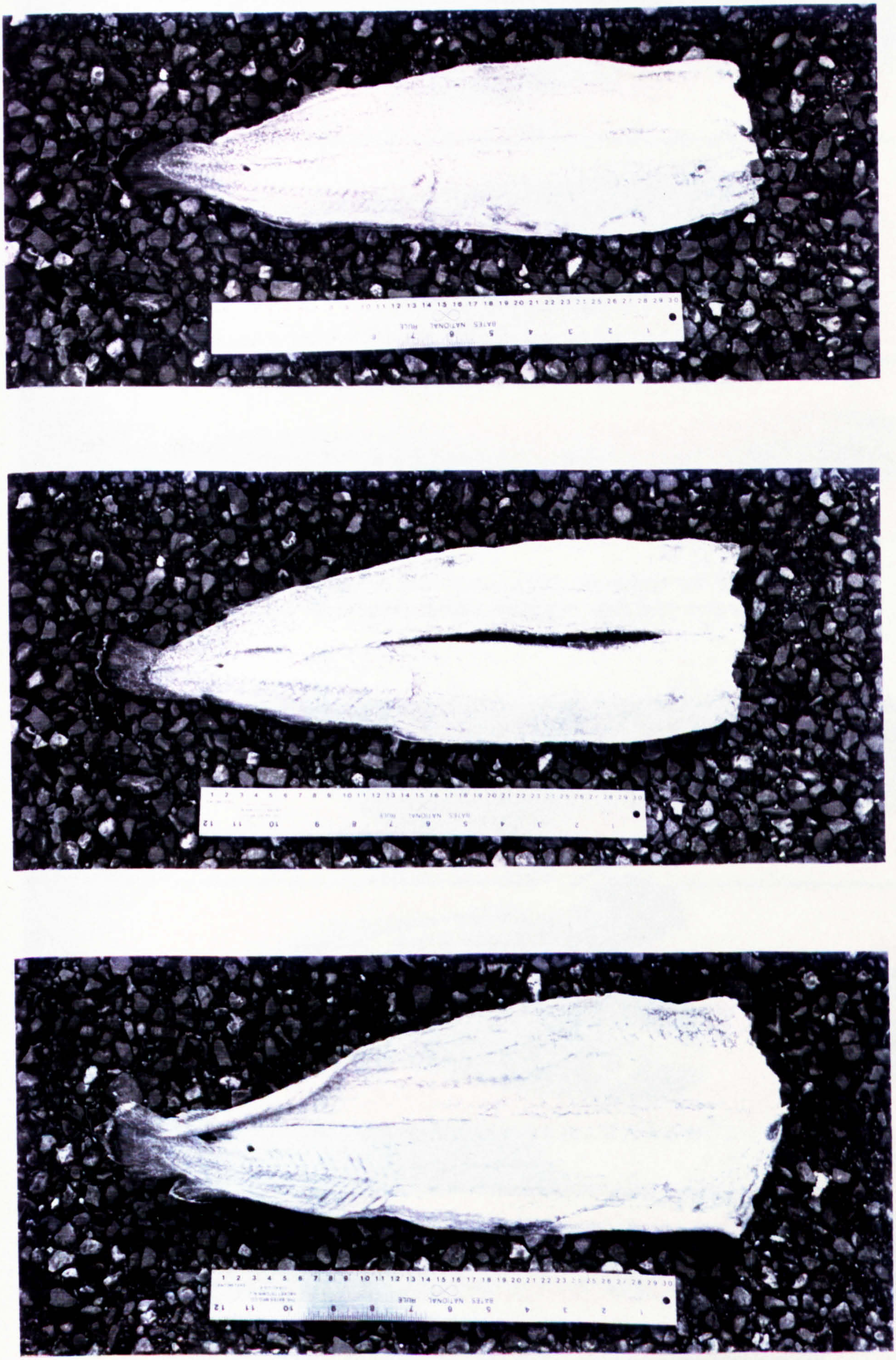


Plate 8.3. Dried salt cod (top), ling (middle) and torsk (bottom) processed in Kirkwall, Orkney, in 1995. Caudal vertebrae have been left in the cured product.

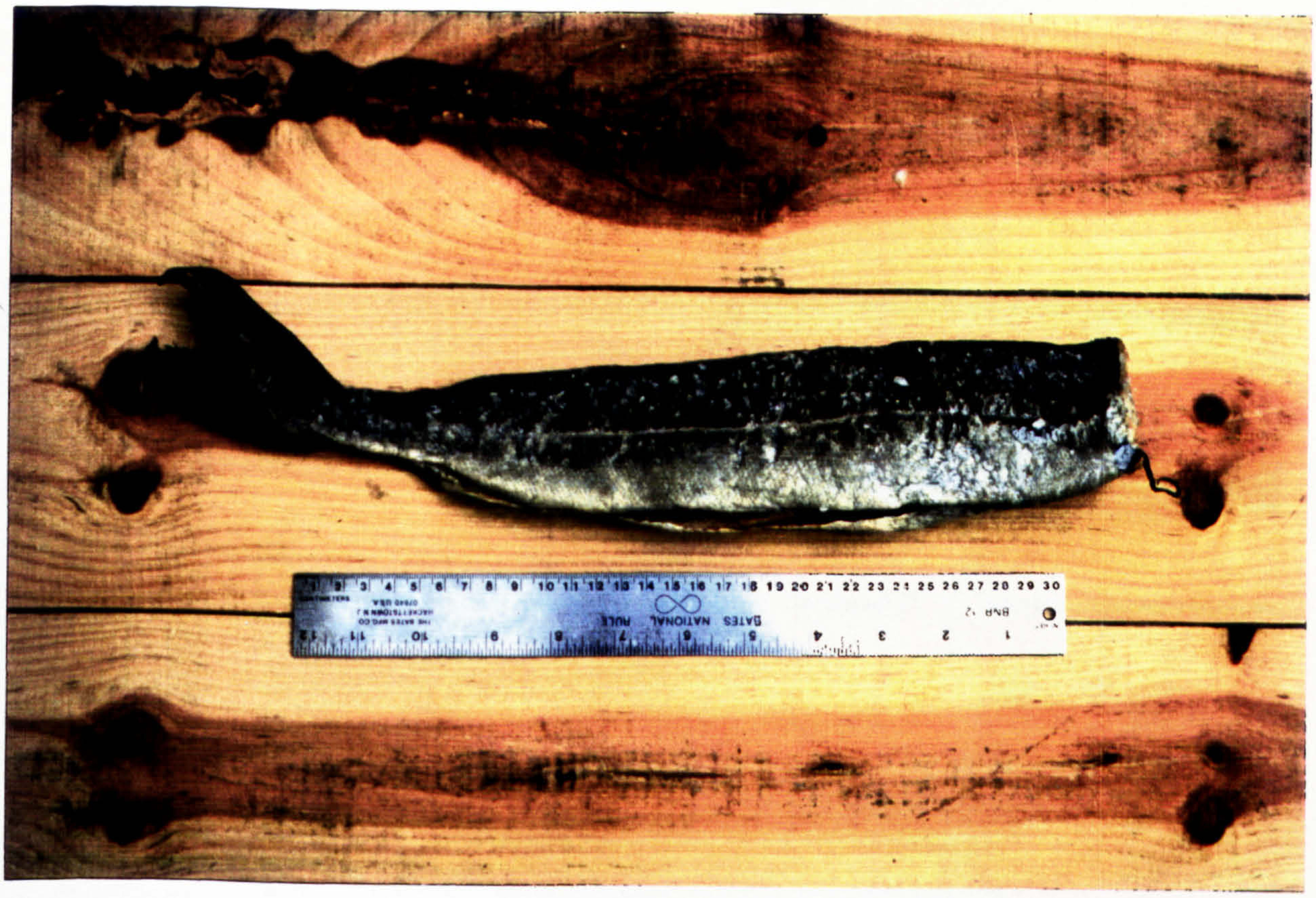


Plate 8.4. Dried salt saith processed in Shetland in 1991. Vertebrae are left in the processed fish, but most appendicular elements have been removed with the head.

Plate 8.5. Dried salt whiting processed in Shetland in 1991. They have been decapitated by cutting through the appendicular skeleton - leaving vertebrae and cut portions of cleithra in the finished product.

Plate 8.6. Dried salt ling processed in Shetland in 1991. All bones, including vertebrae, have been removed.

Plate 8.7. Dried salt fish (cod?) at Chalmer's fish store, Kirkwall, Orkney c.1900. Note that caudal vertebrae and cleithra appear to be left in place (photographer: Tom Kent, reproduced by kind permission of the Orkney Library).

Plate 8.8. Drying salt fish (cod?) in Kirkwall, Orkney c.1900. Note St. Magnus Cathedral in the background (photographer: Tom Kent, reproduced by kind permission of the Orkney Library).

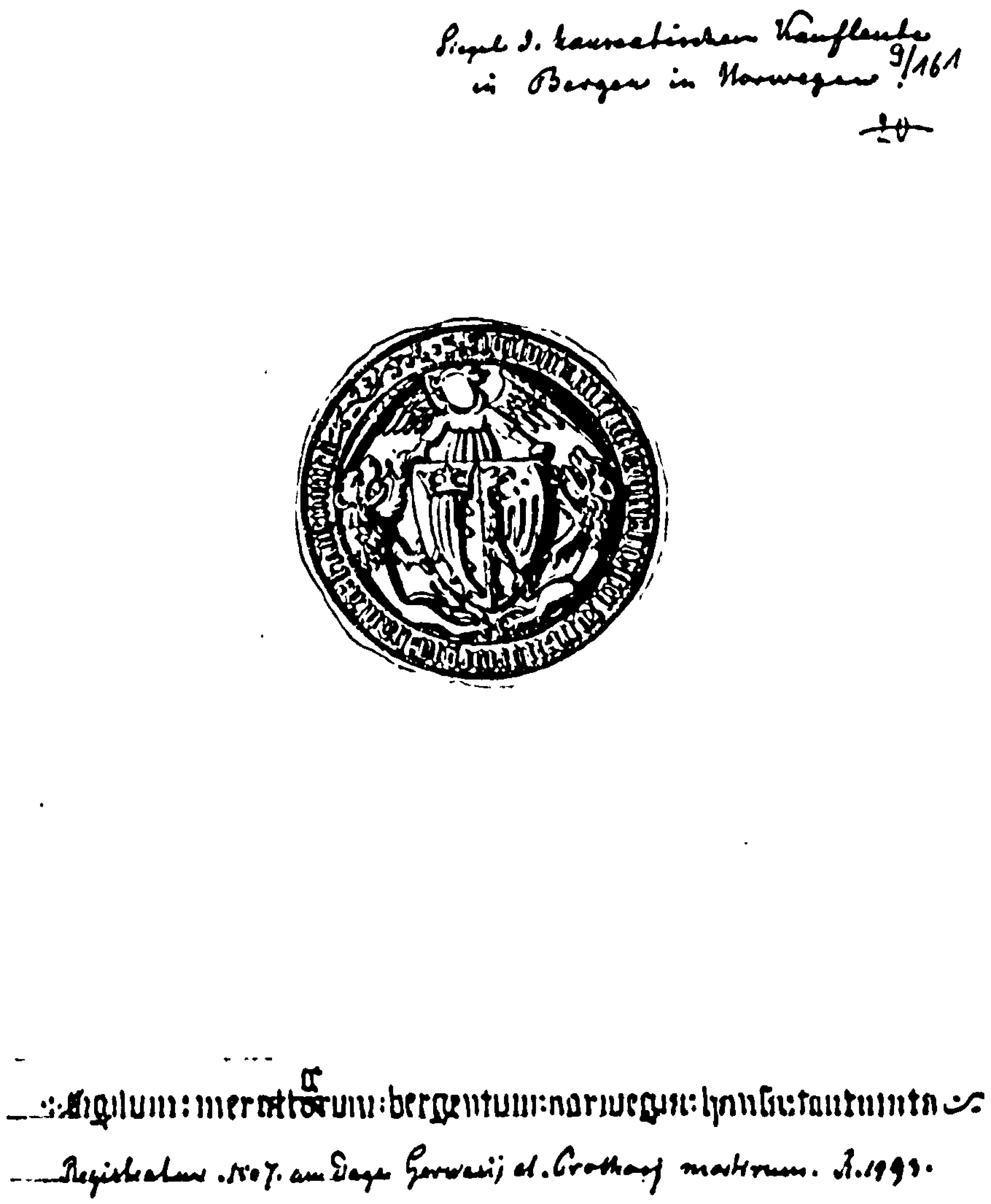


Plate 8.9. Seal of the Hanseatic office in Bergen from 1507. Similar examples also survive from the 15th century (reproduced by kind permission of the Archiv der Hansestadt Lübeck).

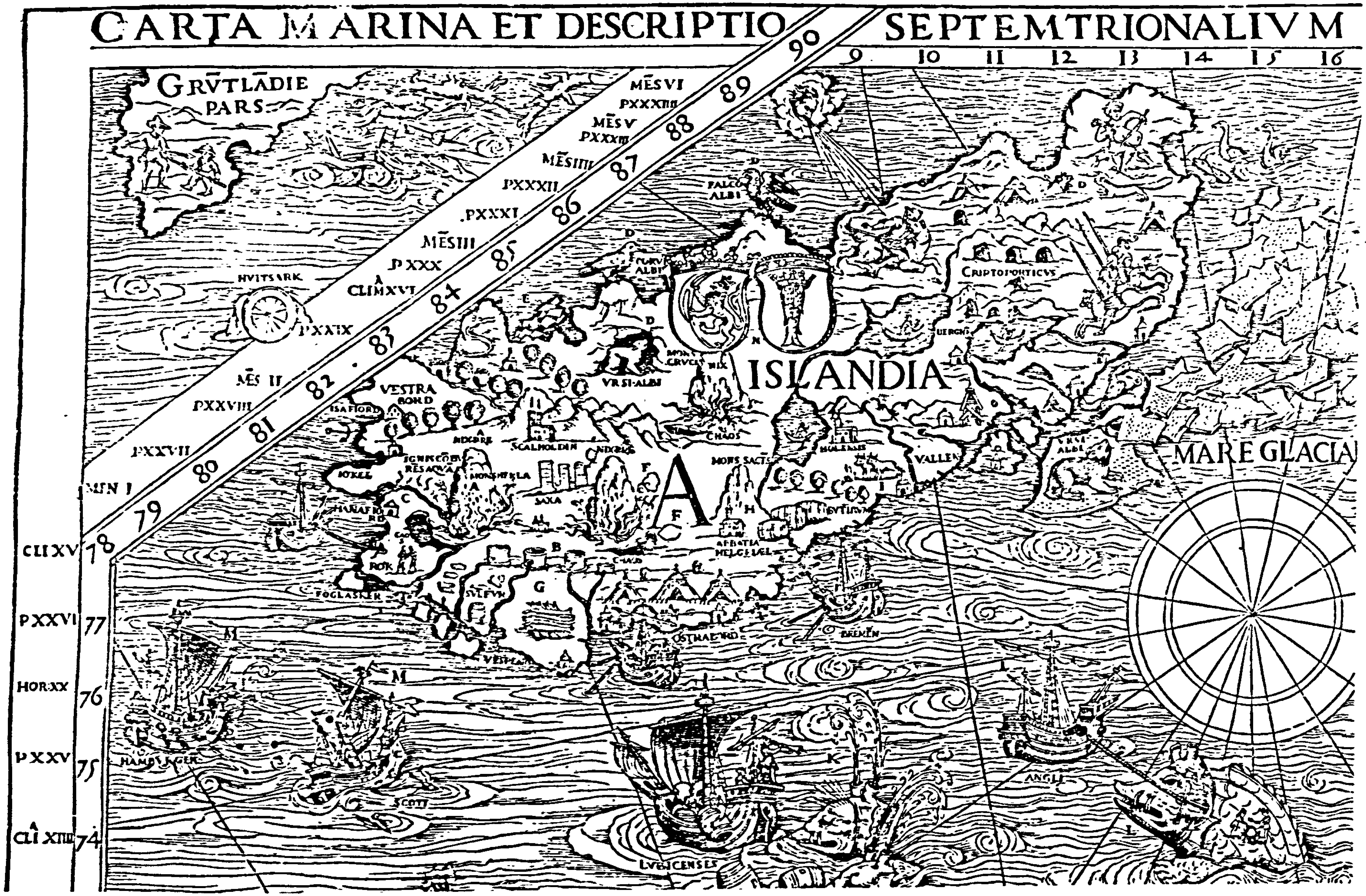


Plate 8.10. Detail of Iceland from the *Carta Marina* of Olaus Magnus (1539). Note the decapitated (cod?) fish used as the island's heraldic device (reproduced by kind permission of the British Library).

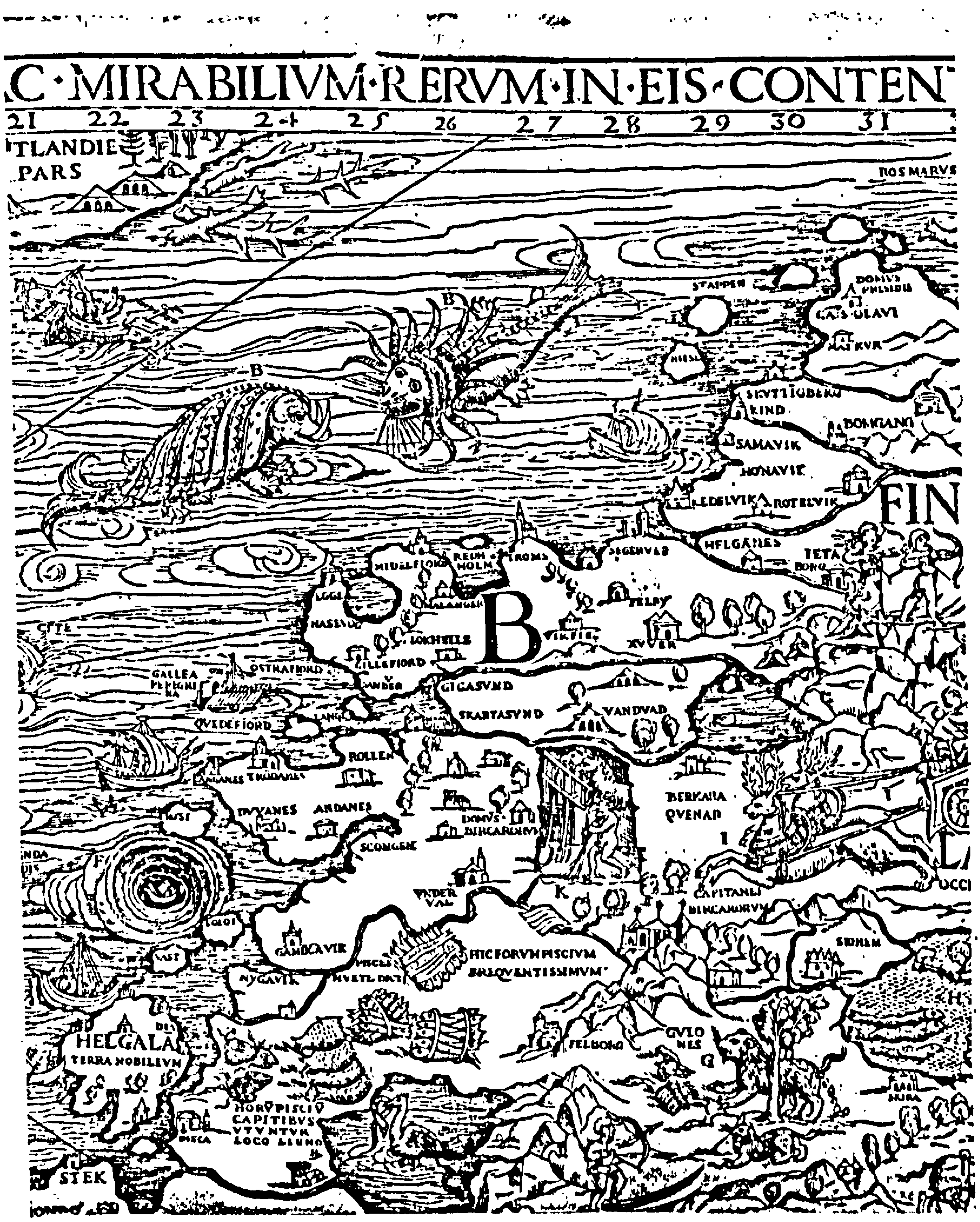


Plate 8.11. Detail of Arctic Norway from the *Carta Marina* of Olaus Magnus (1539). Note the decapitated "market fish" (*FORVMPISCIVM*) (reproduced by kind permission of the British Library).

DE PISCIBVS

De Piſcibus ſalſis, ſiccatis, & fumigatis.

CAP. XXVI.

Plate 8.12. Fish monger from Olaus Magnus' *Historia de Gentibus Septentriona* (1555:722). Note the cured fish in the upper left corner. They are decapitated and possibly split, but the distinct curve at the anterior (bottom) margin suggests that cleithra may have been left in place (reproduced by kind permission of the University of Glasgow Library).

Plate 8.13. Articulated cod vertebrae from Column A, Area A, at Robert's Haven (scale approximately 1.1:1)

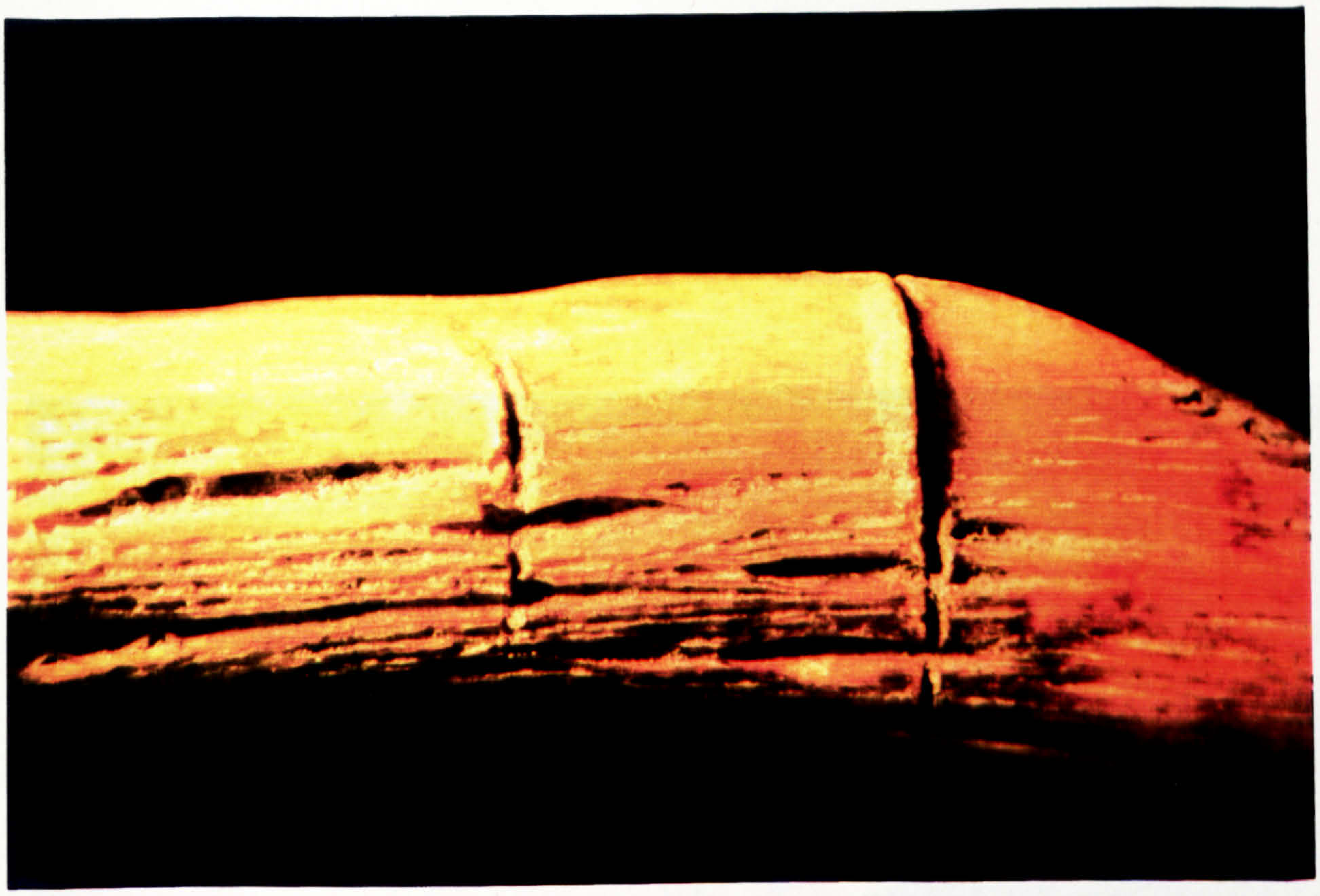


Plate 8.14. Category 3 cut marks (from decapitation) on the right supracleithrum of a saith between 80cm and 100cm in total length.

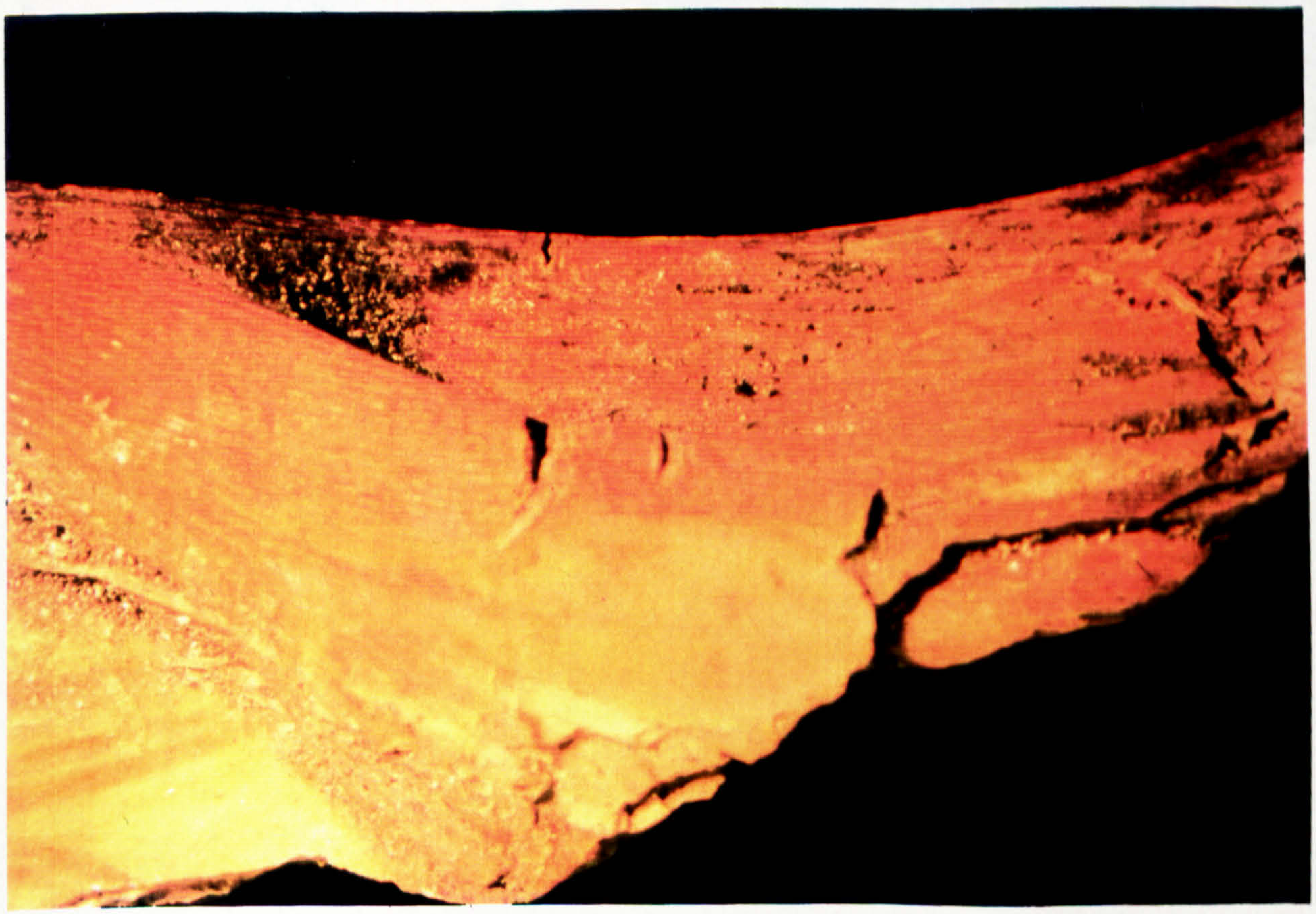


Plate 8.15. Category 3 cut marks (from decapitation) on the anterior margin of the right cleithrum from a cod between 50cm and 80cm in total length.

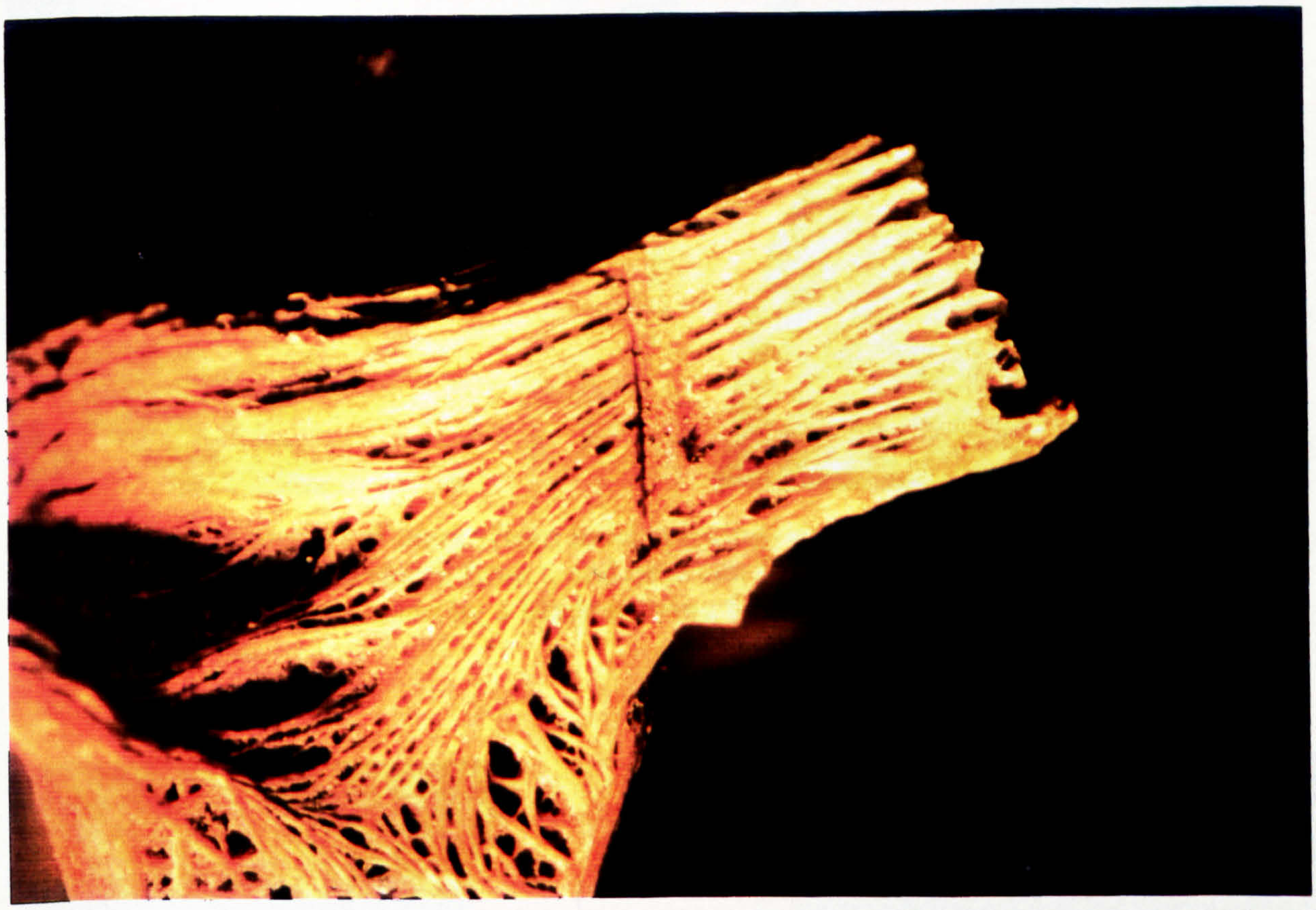


Plate 8.16. Category 3 cut mark (from decapitation) on the right side of the first vertebra (probably) from a saith between 50cm and 80cm in total length.

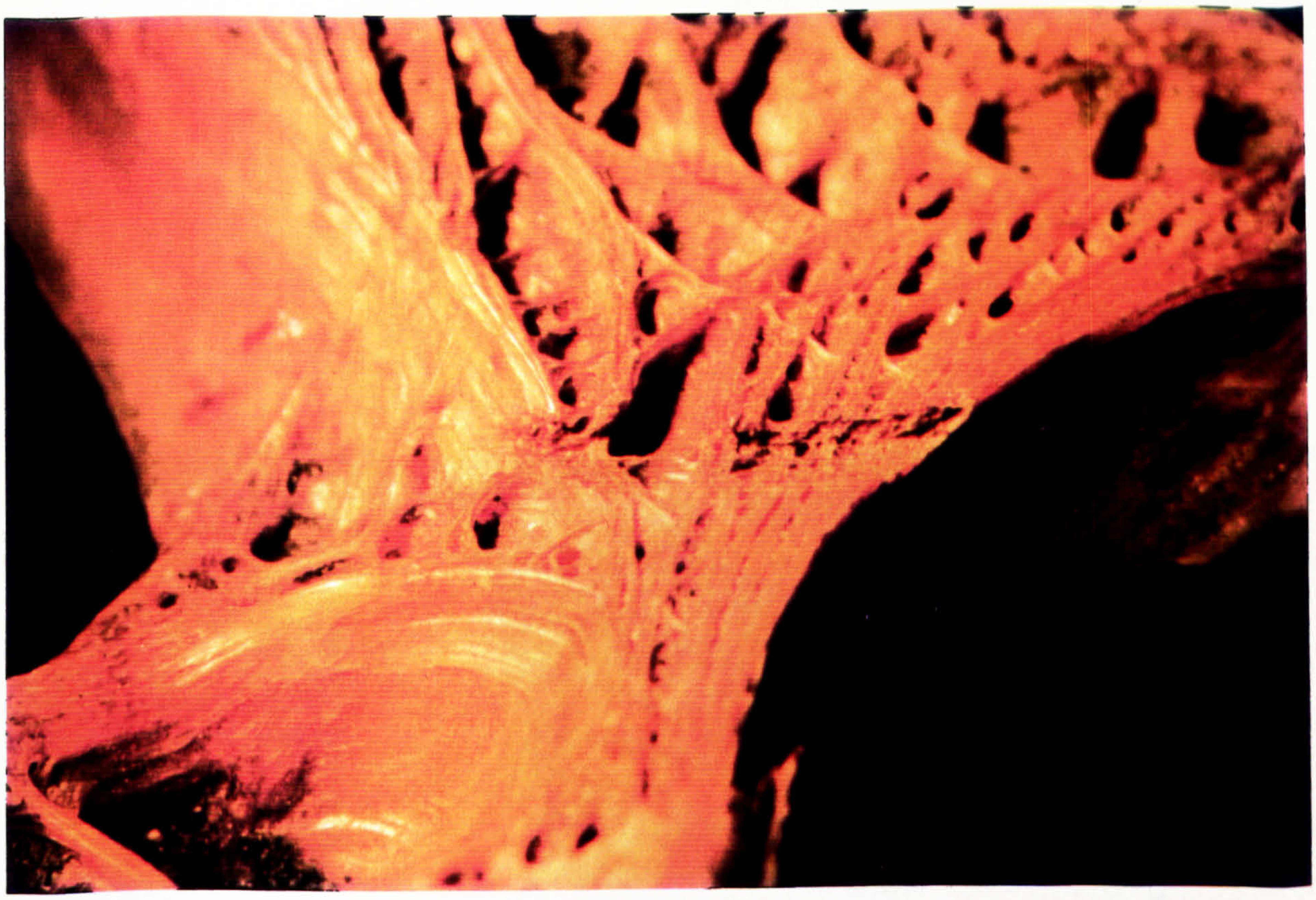


Plate 8.17. Category 5 cut mark (from axial splitting) on the right neural arch of an abdominal vertebra from a cod between 80cm and 100cm in total length. The cut has been made by a blade moving from ventral to dorsal in the sagittal plane.

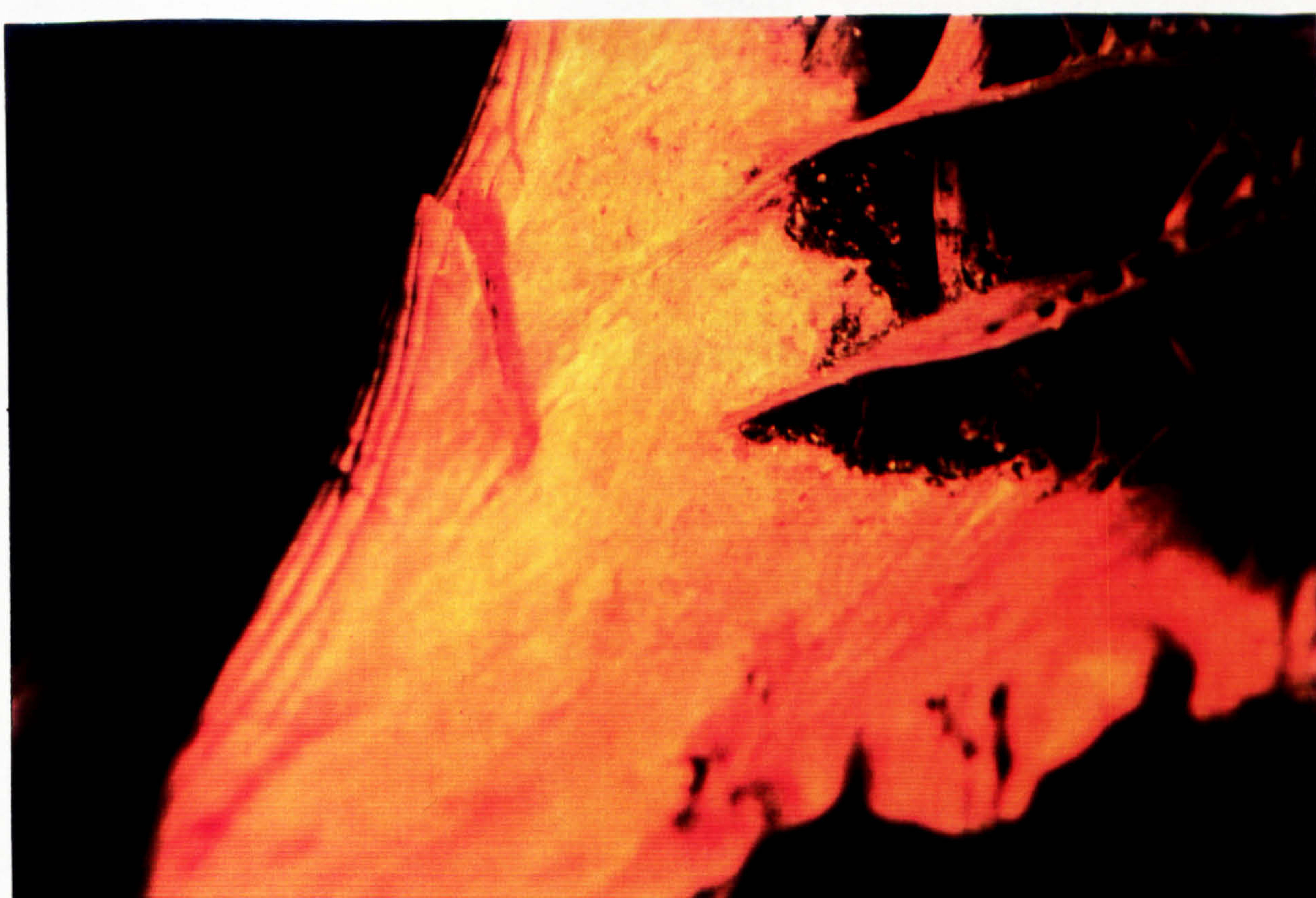


Plate 8.18. Category 5 cut mark (from axial splitting) on the left transverse process of an abdominal vertebra from a cod between 80cm and 100cm in total length. The cut has been made by a blade moving from dorsal to ventral in the sagittal plane.

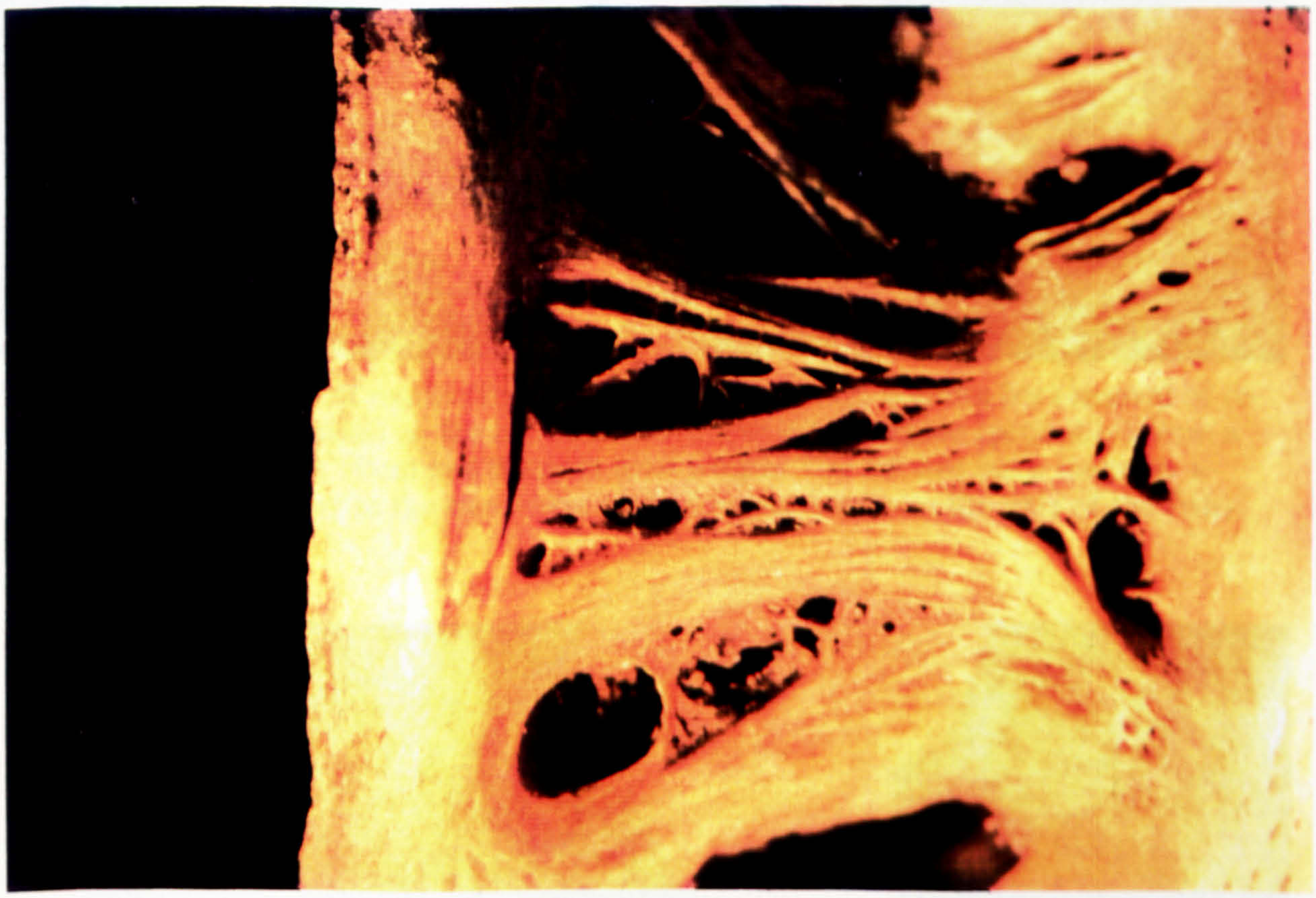


Plate 8.19. Category 5 cut mark (from axial splitting) on the right centrum of a caudal vertebra from a saith of over 100cm in total length. The cut has been made by a blade moving from anterior to posterior in the sagittal plane. This specimen yielded one of the few cut marks noted on posterior caudal vertebrae (CV2).

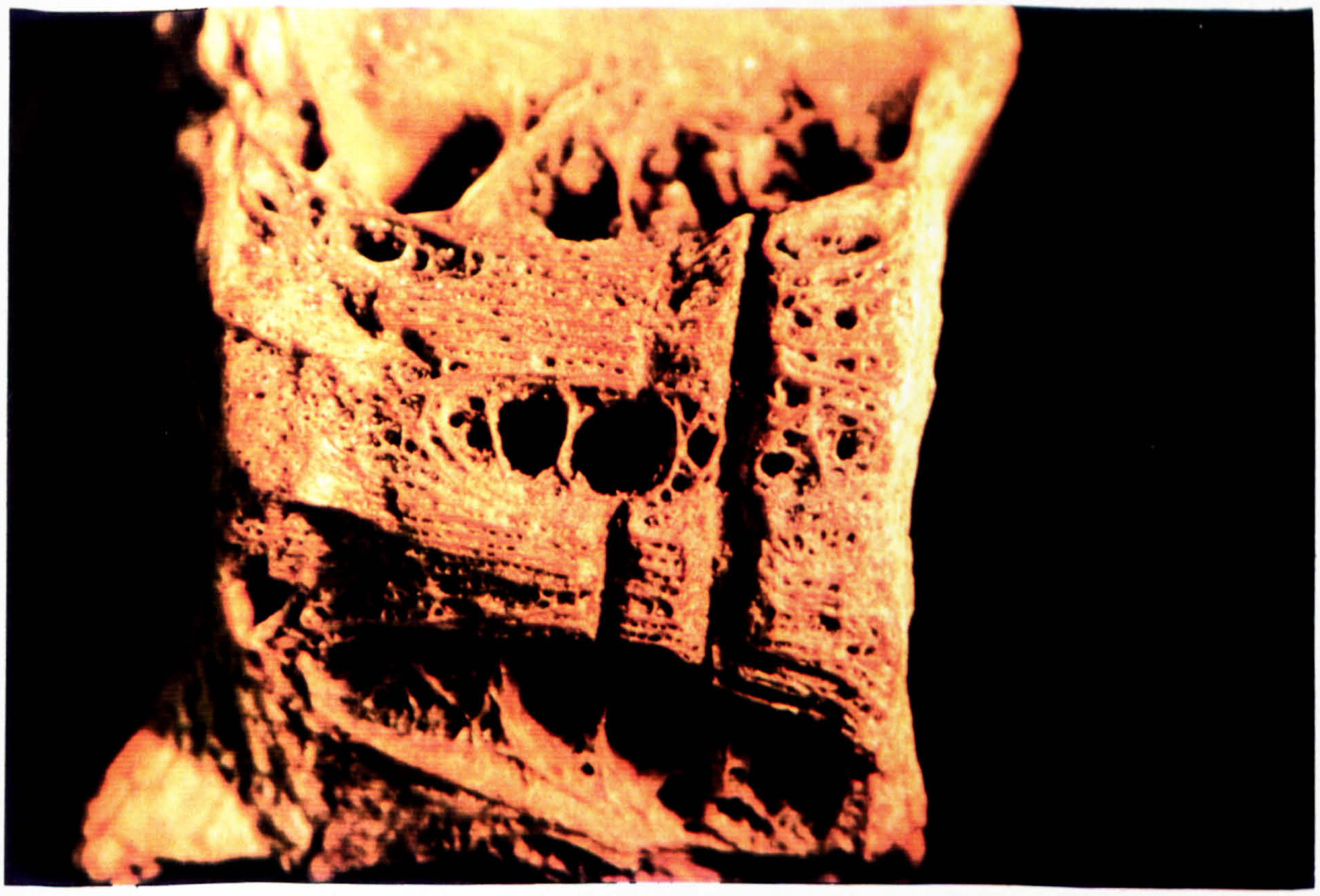


Plate 8.20. Category 6 cut marks (from severing the vertebral column for removal of its anterior portion) on the left centrum of a caudal vertebra (probably) from a cod between 50cm and 80cm in total length. The cut has been made by a blade moving in the transverse plane (perpendicular to the axis of the fish).

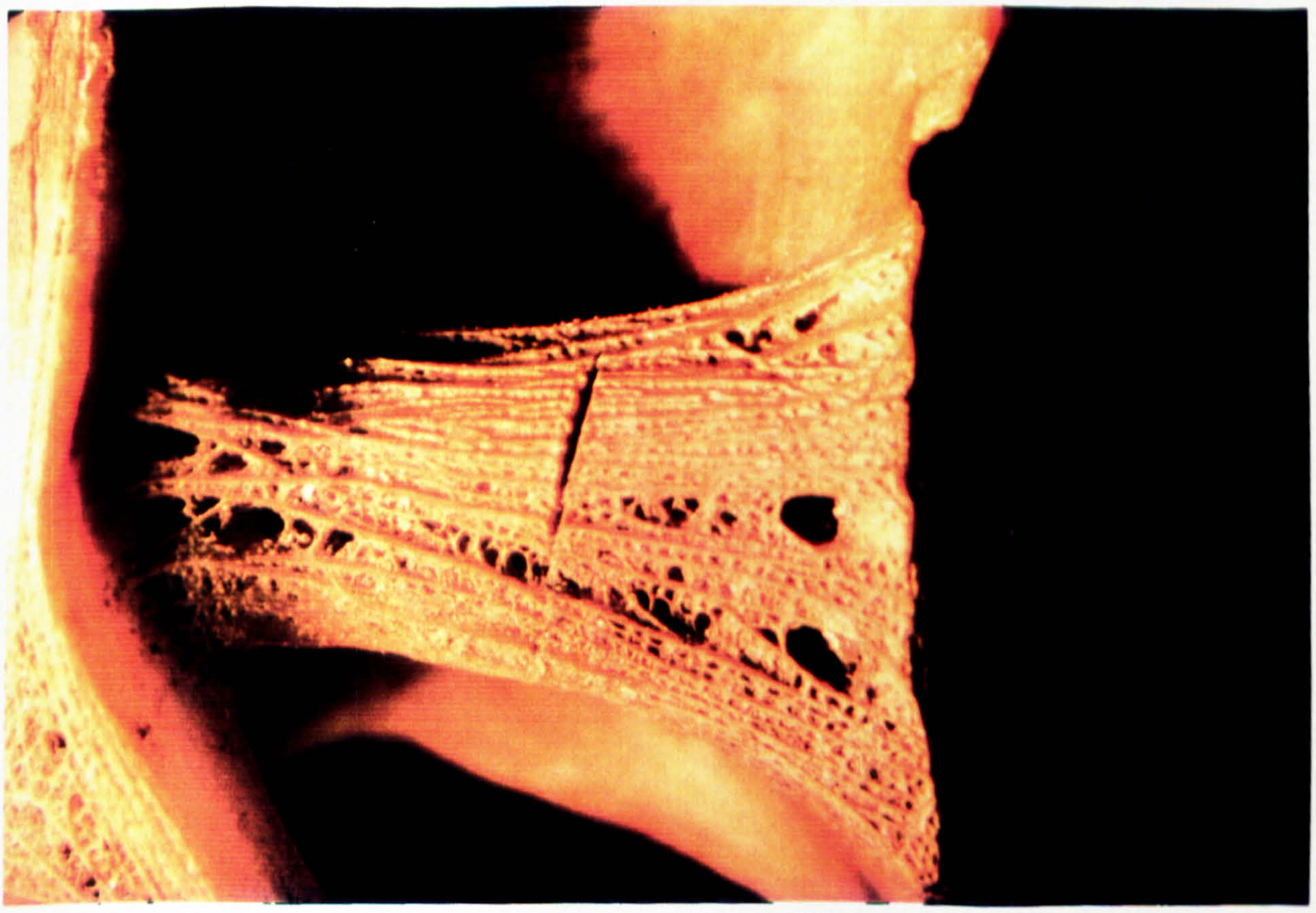


Plate 8.21. Category 6 cut mark (from severing the vertebral column for removal of its anterior portion) on the left centrum of a caudal vertebra from a Ling between 80cm and 100cm in total length. The cut has been made by a blade moving in the transverse plane (perpendicular to the axis of the fish).

Appendix 1.1

Common and Latin names of fauna mentioned in the text

(after Corbet & Harris 1991; Maitland & Campbell 1992; Walters 1980; Whitehead et al. 1986a; 1986b; 1989 with minor exceptions to conform to zooarchaeological practice)

Fish	**Agnatha, Selachii & Osteichthyes**
Common Name	Taxon
River Lamprey	*Lampetra fluviatilis*
Brook Lamprey	*Lampetra planeri*
Sea Lamprey	*Petromyzon marinus*
Shark, Skate, Ray & Chimaera Class	Selachii (Chondrichthyes)
Shark Order	Pleurotremata
Shark, Skate & Ray Orders	Pleurotremata/Hypotremata
Dogfish Family	Scyliorhinidae
Dogfish Families	Scyliorhinidae/Squalidae
Smallspotted Catshark	*Scyliorhinus canicula*
Tope Shark	*Galeorhinus galeus*
Spurdog	*Squalus acanthias*
Ray Family	Rajidae
Thornback Ray	*Raja clavata*
Sturgeon	*Acipenser sturio*
Atlantic Herring	*Clupea harengus*
Salmon & Trout Family	Salmonidae
Salmon/Trout	*Salmo*
Atlantic Salmon	*Salmo salar*
Trout	*Salmo trutta*
Charr	*Salvelinus alpinus*
Pike	*Esox lucius*
Eel	*Anguilla anguilla*
Garfish	*Belone belone*
Three-spined Stickleback	*Gasterosteus aculeatus*
Hake	*Merluccius merluccius*
Cod Family	Gadidae
Cod/Saith/Pollack	*Gadus/Pollachius*
Cod	*Gadus morhua*
Haddock	*Melanogrammus aeglefinus*
Whiting	*Merlangius merlangus*
Saith/Pollack	*Pollachius*
Pollack	*Pollachius pollachius*
Saith	*Pollachius virens*
Norway Pout/Bib/Poor-cod	*Trisopterus*
Bib	*Trisopterus luscus*
Torsk	*Brosme brosme*
Rockling	*Antonogadus/Ciliata/Gaidropsarus*
Bigeye Rockling	*Antonogadus macrophthalmus*
Five-bearded/Northern Rockling	*Ciliata*
Five-bearded Rockling	*Ciliata mustela*
Shore Rockling	*Gaidropsarus mediterraneus*
Three-bearded Rockling	*Gaidropsaurus vulgaris*
Ling	*Molva molva*
Tadpole-fish	*Raniceps raninus*
European Seabass	*Dicentrarchus labrax*
Perch	*Perca fluviatilis*
Atlantic Horse-mackerel	*Trachurus trachurus*
Sea Bream Family	Sparidae
Red Sea Bream	*Pagellus bogaraveo*
Black Sea Bream	*Spondyliosoma cantharus*
Wrasse Family	Labridae
Ballan Wrasse	*Labrus bergylta*
Cuckoo Wrasse	*Labrus bimaculatus*
Corkwing	*Symphodus (Crenilabrus) melops*
Sand Eel Family	Ammodytidae
Greater Sand-eel	*Hyperoplus lanceolatus*
Tuna	*Katsuwonus/Sarda/Thunnus*

Common and Latin names of fauna mentioned in the text

Fish	**Agnatha, Selachii & Osteichthyes**
Atlantic Mackerel	*Scomber scombrus*
Common Goby	*Pomatoschistus microps*
Dragonet	*Callionymus*
Wolf-fish	*Anarhichas lupus*
Butterfish	*Pholis gunnellus*
Thick-lipped Grey Mullet	*Chelon labrosus*
Thinlip Grey Mullet	*Liza ramada*
Gurnard Family	Triglidae
Red Gurnard	*Aspitrigla cuculus*
Grey Gurnard	*Eutrigla gurnardus*
Sea Scorpion Family	Cottidae
Common Name	Taxon
Bullhead	*Cottus gobio*
Bull-rout	*Myoxocephalus scorpius*
Sea Scorpion	*Taurulus bubalis*
Hooknose	*Agonus cataphractus*
Lumpsucker	*Cyclopterus lumpus*
Flatfish Order	Heterosomata (Pleuronectiformes)
Turbot Family	Scophthalmidae
Megrim	*Lepidorhombus whiffiagonis*
Turbot	*Psetta maxima*
Topknot	*Zeugopterus punctatus*
Halibut Family	Pleuronectidae
Halibut	*Hippoglossus hippoglossus*
Dab	*Limanda limanda*
Lemon Sole	*Microstomus kitt*
Flounder	*Platichthys flesus*
Plaice	*Pleuronectes platessa*
Sole	*Solea vulgaris*
Angler	*Lophius piscatorius*

Appendix 1.1 (continued)

Common and Latin names of fauna mentioned in the text

Birds	**Aves**
Common Name	Taxon
Divers	*Gavia*
Great Northern Diver	*Gavia immer*
Red/Black-throated Diver	*Gavia stellata/arctica*
Red-throated Diver	*Gavia stellata*
Fulmar	*Fulmarus glacialis*
Manx Shearwater	*Puffinus puffinus*
Gannet	*Morus bassana*
Cormorant/Shag	*Phalacrocorax*
Cormorant	*Phalacrocorax carbo*
Shag	*Phalacrocorax aristotelis*
Grey Heron	*Ardea cinerea*
Swan, Goose & Duck Family	Anatidae
Swans	*Cygnus*
Mute Swan	*Cygnus olor*
Whooper Swan	*Cygnus cygnus*
Goose	*Anser*
Domestic/Wild Greylag Goose	*Anser anser*
Goose	*Anser/Branta*
Shelduck	*Tadorna tadorna*
Mallard	*Anas platyrhynchos*
Teal	*Anas crecca*
Wigeon	*Anas penelope*
Shoveler	*Anas clypeata*
Eider	*Somateria mollissima*
Pochard	*Aythya ferina*
Red-breasted Merganser	*Mergus serrator*
White-tailed Eagle	*Haliaeetus albicilla*
White-tailed Eagle/Golden Eagle	*Haliaeetus albicilla/Aquila chrysaetos*
Goshawk	*Accipiter gentilis*
Buzzard	*Buteo buteo*
Kestrel	*Falco tinnunculus*
Merlin	*Falco columbarius*
Grouse Family	Tetraeonidae
Red Grouse	*Lagopus scoticus*
Fowl	*Gallus gallus*
Turkey	*Meleagris gallopavo*
Crane	*Grus grus*
Wader	*Haematopodidae/Charadriidae/Scolopacidae/Phalaropodidae*
Oystercatcher	*Haematopus ostralegus*
Water Rail	*Rallus aquaticus*
Lapwing	*Vanellus vanellus*
Plovers	Charadriformes
Plovers	*Pluvialis*
Golden Plover	*Pluvialis apricaria*
Sandpiper & Snipe Family	Scolopacidae
Dunlin	*Calidris alpina*
Knot	*Calidris canutus*
Curlews	*Numenius*
Curlew	*Numenius arquata*
Whimbrel	*Numenius phaeopus*
Greenshank	*Tringa nebularia*
Snipe	*Gallinago*
Grey Phalarope	*Phalaropus fulicarius*
Pomarine Skua	*Stercorarius pomarinus*
Gull Family	Laridae
Common Gull/Kittiwake	*Larus canus/Larus tridactylus*
Common Gull	*Larus canus*

Appendix 1.1 (continued)

Common and Latin names of fauna mentioned in the text

Birds	**Aves**
Common Name	Taxon
Herring/Lesser Black-back	*Larus argentatus/fuscus*
Herring Gull	*Larus argentatus*
Lesser Black-backed Gull	*Larus fuscus*
Great Black-backed/Glaucous Gull	*Larus marinus/hyperboreus*
Great Black-backed Gull	*Larus marinus*
Terns	*Sterna*
Kittiwake	*Larus tridactylus*
Auk Family	Alcidae
Great Auk	*Pinguinus impennis*
Razorbill/Guillemot	*Alca torda/Uria aalge*
Razorbill	*Alca torda*
Guillemot	*Uria aalge*
Puffin/Black Guillemot	*Fratercula arctica/Cepphus grylle*
Puffin	*Fratercula arctica*
Black Guillemot	*Cepphus grylle*
Little Auk	*Plotus alle*
Dove/Pigeon Subfamily	Columbinae
Rock/Stock Dove	*Columba livia/oenas*
Rock Dove	*Columba livia*
Stock Dove	*Columba oenas*
Wood Pigeon	*Columba palumbus*
Short-eared Owl	*Asio flammeus*
Passerine Subfamily	Passerinae
Small Passerines	Small Passerines
Thrush & Chat Family	Turdidae
Blackbird/Ring Ouzel	*Turdus merula/torquatus*
Redwing/Song Thrush	*Turdus iliacus/philomelus*
Starling	*Sturnus vulgaris*
Crows	*Corvus*
Rook/Crow	*Corvus frugilegus/corone*
Carrion Crow	*Corvus corone*
Raven	*Corvus corax*

Common and Latin names of fauna mentioned in the text

Mammals	**Mammalia**
Common Name	Taxon
Hedgehog	*Erinaceus europaeus*
Pygmy Shrew	*Sorex minutus*
Rabbit	*Oryctolagus cuniculus*
Brown Hare	*Lepus europaeus*
Mountain Hare	*Lepus timidus*
Rodent Order	Rodentia
Vole	*Clethrionomys/Microtus/Arvicola*
Bank Vole	*Clethrionomys glareolus*
Orkney Vole	*Microtus arvalis*
Water Vole	*Arvicola terrestris*
Mouse	*Apodemus/Mus*
Wood Mouse	*Apodemus sylvaticus*
House Mouse	*Mus musculus*
Common Rat	*Rattus norvegicus*
Ship Rat	*Rattus rattus*
Whale Order	Cetacea
Long-finned Pilot Whale	*Globicephala melas*
Carnivore Order	Carnivora
Wolf	*Canis lupus*
Dog	*Canis familiaris*
Fox	*Vulpes vulpes*
Stoat	*Mustela erminea*
Otter	*Lutra lutra*
Wild Cat	*Felis silvestris*
Domestic Cat	*Felis catus*
Seal Family	Phocidae
Common Seal	*Phoca vitulina*
Grey Seal	*Halichoerus grypus*
Horse	*Equus caballus*
Pig	*Sus scrofa*
Deer Family	Cervidae
Red Deer	*Cervus elaphus*
Roe Deer	*Capreolus capreolus*
Reindeer	*Rangifer tarandus*
Cattle	*Bos taurus*
Sheep/Goat	*Ovis/Capra*
Goat	*Capra hircus*
Sheep	*Ovis aries*

Appendix 3.1

Excavated 'sites' mentioned in the text

Orkney

Site or Sites	Site Type	VA	*VA1*	*VA2*	LN	*LN1*	*LN2*	References
		Viking Age			Late Norse			
St. Boniface (p)	middens				√			Cerón-Carrasco 1994; Lowe 1990; 1993
Quoygrew (p)	middens				√			Colley 1983a; 1984
Langskaill	farm mound				√		√	Davidson et al. 1986
Tuquoy (p)	settlement & middens	√			√	√	√	Owen 1993; pers comm.
Pool (p)	settlement & middens	√	√	√	√	√		Bond 1994; Hunter pers comm.; Hunter et al. 1990; 1993
Westness Settlement (p)	settlement & middens				√?			Kaland 1973; 1993
Brough of Birsay Early Excavations	settlement & chapel	√		√	√	√		Curle 1982
Brough of Birsay Room 5	settlement & middens	√		√				Hunter & Morris 1982
Brough of Birsay Sites VII-IX	settlement & middens	√		√	√	√		Hunter 1986
Brough of Birsay Areas 1-6 (p)	settlement & middens	√			√			Morris pers comm.; Renfrew & Buteux 1985
Buckquoy Settlement	settlement & middens	√						Ritchie 1976-1977
Brough Road Areas 1 & 2	middens	√						Morris 1989
St. Magnus Church, Birsay	church				√	√		Barber forthcoming
Beachview Burnside Area 2	middens				√	√		Morris forthcoming a
Beachview Studio Site	settlement & middens				√	√		Morris forthcoming a
Saevar Howe	settlement & middens	√						Hedges 1983
Tankerness House, Kirkwall	fill				√		√	McGavin 1982
Brough of Deerness	chapel	√			√	√	√	Morris & Emery 1986
Skaill, Deerness	settlement & middens	√			√?			Buteux forthcoming; Gelling 1984
Newark Bay (p)	chapel	√		√?				Brothwell 1977; Stevenson 1986
Earl's Bu (p)	settlement, mill & middens	√			√	√	√	Batey 1993a; Batey pers comm
Broch of Burgar	hoard	√						Graham-Campbell 1985; 1993
Skaill	hoard	√		√				Graham-Campbell 1976 ; 1993
Stenness	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Ring of Brodgar	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Burray	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Caldale	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Orkney Graves (see Appendix 3.3)								

Caithness

Site or Sites	Site Type	VA	*VA1*	*VA2*	LN	*LN1*	*LN2*	References
		Viking Age			Late Norse			
Robert's Haven (p)	settlement & middens				√		√	this study; Morris et al. 1994
Bishop's Castle, Scrabster (p)	castle				√			Talbot 1970; 1973a; 1973b
Freswick Links	settlement & middens	√		√	√	√		Batey 1987a; Morris et al. forthcoming a
Freswick Castle	settlement & middens				√?			Batey et al. 1984
Clow chapel (p)	chapel				√		√	Talbot 1977; 1980
Kirk o' Banks	hoard	√		√ *or LN1*				Graham-Campbell 1976 :126, 128-130; 1993:184
Ladykirk	hoard				√		√	Stewart 1973:135
Braemore	hoard				√		√	Stewart 1973:139
Caithness Graves (see Appendix 3.3)								

Shetland

Site or Sites	Site Type	VA	*VA1*	*VA2*	LN	*LN1*	*LN2*	References
		Viking Age			Late Norse			
Sandwick (p)	settlement & middens				√	√	√	Bigelow 1984; 1985; 1987; 1989
Underhoull	settlement & middens				√?	√?		Bigelow 1984; 1987; Small 1966
Kebister (p)	possible VA chapel & LN fill	√			√		√	Owen & Smith 1988; Owen 1993
Jarlshof	settlement & middens	√	√?	√	√	√	√	Ashmore 1993; Hamilton 1956
The Biggins (p)	settlement				√			Crawford 1985a; 1991
Dunrossness Manse	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Garthbanks/ Quendale	hoard	√		√ *or LN1*				Graham-Campbell 1976 ; 1993
Shetland Graves (see Appendix 3.3)								

Appendix 3.2

Unexcavated (or 'cleared') buildings mentioned in the text

Orkney

Building	Suggested Date of Primary Phase(s) (As Published)	References
St. Magnus Church, Egilsay	12th century	Fernie 1988
Cubbie Roo's Castle, Wyre	12th century	Lamb 1980a:94; RCAMS 1946a:235-9
The Wirk, Rousay	13th or 14th century	Clouston 1931; Lamb 1993b:53-4
Castle Howe, Holm	Late Norse?	Clouston 1931:33-5; Lamb 1980a:94
St. Olaf's Church, Kirkwall	12th century	Lamb 1993a:46; RCAMS 1946a:141-142
St. Magnus Cathedral, Kirkwall	12th century	Cambridge 1988; Cruden 1988; Fawcett 1988
Bishop's Palace, Kirkwall	12th century	Simpson 1961
St. Nicholas Chapel, Orphir	12th century	Fisher 1993

Caithness (Including Sutherland)

Building	Suggested Date of Primary Phase(s) (As Published)	References
Castle of Brough, Dunnet	Late Norse?	Lamb 1980a:90-96
St. Peter's Church, Thurso	12th or 13th century	Slade & Watson 1989
St. Mary's Chapel, Crosskirk	12th century	Gifford 1992:115
Bucholie Castle, Canisbay	15th century (Possibly on site of earlier castle)	Batey 1987b:22; 1991a:32; Gifford 1992:108; Lamb 1980a:96
Braal Castle, Halkirk	14th century	Gifford 1992:107
Castle of Old Wick, Wick	12th or 13th century	Lamb 1980a:90-96; RCAMS 1911b: 137-139; Talbot 1974:40
Forse Castle, Latheron	12th or 13th century	Gifford 1992:117
Borve Castle, Farr	Late Norse?	Lamb 1980a:90-96
Dornoch Cathedral, Dornoch	Late Norse 2	Gifford 1992:562-567

Shetland

Building	Suggested Date of Primary Phase(s) (As Published)	References
St. Mary's Church, Bressay	Late Norse	Gifford 1992:470-1; RCAMS 1946b:1
Lambhoga Head (Castle?), Dunrossness	Late Norse or Post-medieval	Lamb 1980a:95-6

Appendix 3.3

Viking Age and Late Norse Graves in Orkney, Caithness and Shetland

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	?	Graemsay	Mainland	Mainland	Mainland
Grave	Island near Mainland	Graemsay	Broch of Gurness	Brough of Deerness, BS	Brough of Deerness, DQ
Quality of Evidence	c	a	a	a	a
Period (As Published)	VA	LN1	VA2	VA2-LN1	VA?
References	Grieg 1940:86	Hedges 1978:374-378	Hedges 1987:73-74, 86-87; Robertson 1969: 289-90	Morris & Emery 1986:325, 347, 350	Morris & Emery 1986:314, 320, 357-8
Skeleton Present		yes	yes	yes	yes
Osteological Sex		male	?	male	?
Osteological Age		40-45	?	24-39	c.5 months
Grave Location	in a "big mound"	sandy shore-line	broch rampart	chapel enclosure	chapel enclosure
Grave-Goods	yes	no	yes	no	no
Armlet (Iron)					
Armlet (Jet)	√				
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Equal-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)			√		
Mount(s) or Strap End(s)					
Necklet (iron)			√		
Oval Brooch(es)	√		√		
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)	√				
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss					
Spear(s)					
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle			√		
Spindle Whorl(s)	√				
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	4	0	4	0	0

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Mainland	Mainland	Mainland	Mainland	Mainland
Grave	Brough of Deerness, GC	Brough of Deerness, GO	Brough of Deerness, GP	Brough of Deerness, GQ	Brough Road Area 1, no.1
Quality of Evidence	a	a	a	a	a
Period (As Published)	VA2-LN1	VA2-LN1	VA2-LN1	VA?	VA2 (or LN1)
References	Morris & Emery 1986:325, 347, 357	Morris & Emery 1986:323-4, 348, 357	Morris & Emery 1986:323-4, 347-8, 357	Morris & Emery 1986:314, 320, 357-8	Lunt & Young 1989:273; Morris 1989:114, 120, 123
Skeleton Present	yes	no	yes	yes	yes
Osteological Sex	?	?	?	?	?
Osteological Age	6.5-9	infant?	neonatal	infant?	adult
Grave Location	chapel enclosure	chapel enclosure	chapel enclosure	chapel enclosure	midden
Grave-Goods	no	no	no	no	no
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)					
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss					
Spear(s)					
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	0	0	0	0	0

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Mainland	Mainland	Mainland	Mainland	Mainland
Grave	Brough Road Area 1, no.2	Brough Road Area 2, no.1	Buckquoy adult	Buckquoy Infant	Howe
Quality of Evidence	a	b	a	a	e
Period (As Published)	VA	VA2	VA2	VA	VA
References	Lunt & Young 1989:273-4; Morris 1989:114, 120, 123, 127	Lunt & Young 1989:274-5; Morris 1989:137, 141	Ritchie 1976-1977:190-191	Ritchie 1976-1977:188, 192	Grieg 1940:80-81
Skeleton Present	yes	yes	yes	yes	
Osteological Sex	male	female?	male	?	
Osteological Age	>30, ?>50	middle age	40+	neonatal	
Grave Location	midden	midden	settlement mound	house floor	in mound
Grave-Goods	yes	yes	yes	no	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)			√		
Comb(s)	√				
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)	√	√	√		
Mount(s) or Strap End(s)			√		
Necklet (iron)					
Oval Brooch(es)					
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)			√		
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss					
Spear(s)			√		
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					√
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone			√		
Nail(s)/Rivet(s)	√				
Unidentified Iron Object(s)	√				
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin			√		
No. of Grave-good Categories	4	1	7	0	1

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Mainland	Mainland	Rousay	Rousay	Rousay
Grave	Lyking	Skaill	Knowe of Swandro	Westness 1	Westness 11
Quality of Evidence	c	a	e	a	c
Period (As Published)	VA	VA	VA1	VA1	VA1
References	Grieg 1940:80; RCAMS 1946a:272; Shetelig 1945:7	Grieg 1940:81-83; Shetelig 1945:45-6; Watt 1888:283	Grieg 1940:88-90; RCAMS 1946a:220; Shetelig 1945:7	Kaland 1973:94-5, 100; 1993: 314; Stevenson 1968:25-6; 1989:239-41	Kaland 1980; 1993:315-316
Skeleton Present		yes		yes	yes
Osteological Sex				female	male
Osteological Age				adult	?
Grave Location		sandy bank		flat cemetery	flat cemetery
Grave-Goods	yes	yes	yes	yes	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)				√	
Bell					
Bronze Box					
Buckle(s)	√				
Comb(s)	√	√		√	√
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)		√		√	
Mount(s) or Strap End(s)				√	
Necklet (iron)					
Oval Brooch(es)				√	
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)				√	
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					√
Axe(s)					√
Shield Boss			√		√
Spear(s)	√	√			
Sword			√		√
Adze					?
Balance Weights					
Boat					√
Bronze Vessel				√	
Fishing Weight					√
Hackle(s) (Iron)				√	
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice				√	
Shears (Iron)				√	
Sickle				√	?
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword				√	
Whale Bone Plaque				√	
Whetstone		√			
Nail(s)/Rivet(s)		√			
Unidentified Iron Object(s)		√			
Dog Bones					
Horse Bones		?			
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	3	6	2	13	7

Region	Orkney	Orkney	Orkney	Orkney
Island	Rousay	Rousay	Rousay	Rousay
Grave	Westness 2	Westness 3	Westness 31	Westness 5 or 12
Quality of Evidence	a	a	a	a
Period (As Published)	VA1	VA1	VA1	VA1
References	Kaland 1973:100; 1993:313	Kaland 1973:100; 1993:313	Kaland 1980; 1993:314-316	Kaland 1980:Figure 2; 1993:313
Skeleton Present	yes	partially	yes	yes
Osteological Sex	male	?	male	female
Osteological Age	young adult	?	?	?
Grave Location	flat cemetery	flat cemetery	flat cemetery	flat cemetery
Grave-Goods	yes	yes	yes	yes
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)	√	√		
Bell				
Bronze Box				
Buckle(s)				
Comb(s)	√			√
Dice	√			
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)	√	√		
Mount(s) or Strap End(s)	√			
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				√
Ringed Pin(s)	√			
Trefoil Brooch				
Tweezers				
Arrow(s)	√		√	
Axe(s)			√	
Shield Boss	√		√	
Spear(s)			√	
Sword			√	
Adze			√	
Balance Weights				
Boat			√	
Bronze Vessel		√		
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)		√		
Needle(s)				
Pumice				
Shears (Iron)				
Sickle	√		√	√
Spindle Whorl(s)				√
Strike-a-Light			√	
Weaving Sword		√		
Whale Bone Plaque				
Whetstone			√	
Nail(s)/Rivet(s)		√		
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	9	6	10	4

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Sanday	Sanday	Sanday	Sanday	Sanday
Grave	Braeswick	Lamba Ness (NMS IL179-181)	Lamba Ness (NMS IL347-350)	Scar, Child	Scar, Female
Quality of Evidence	c	c	c	b	b
Period (As Published)	VA1	VA2	VA2	VA1	VA1
References	Grieg 1940:88; RCAMS 1946:45; Shetelig 1945:6	Grieg 1940:86; RCAMS 1946a:44-45; Shetelig 1945:6	Grieg 1940:86-88; RCAMS 1946a:45; Shetelig 1945:6	Owen & Dalland 1994:159-172	Owen & Dalland 1994:159-172
Skeleton Present				yes	yes
Osteological Sex				?	female
Osteological Age				c.10	70's
Grave Location				sandy shore-line	sandy shore-line
Grave-Goods	yes	yes		?	yes
Armlet (Iron)					
Armlet (Jet)			√		
Armlet (Silver)					
Bead(s)	√		√		
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					√
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					√
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)	√		√		
Penannular Brooch(es)			√		
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)		√			
Shield Boss					
Spear(s)		√			
Sword		√			
Adze					
Balance Weights					
Boat				√	√
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					√
Pumice					
Shears (Iron)					√
Sickle					√
Spindle Whorl(s)					√
Strike-a-Light					
Weaving Sword					√
Whale Bone Plaque					√
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	2	3	4	1	9

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Sanday	Sanday	Westray	Westray	Westray
Grave	Scar, Male	Sties	Pierowall 1	Pierowall 2	Pierowall 3
Quality of Evidence	b	e	c	c	c
Period (As Published)	VA1	VA	VA1?	VA1?	VA1?
References	Owen & Dalland 1994:159-172	RCAMS 1946a:44	Shetelig 1945:6; Thorsteinsson 1968:164-5	Shetelig 1945:6; Thorsteinsson 1968:165	Shetelig 1945:6; Thorsteinsson 1968:165-6
Skeleton Present	yes		yes	yes	yes
Osteological Sex	male				
Osteological Age	30's				
Grave Location	sandy shore-line		sand links, in mound	sand links	sand links
Grave-Goods	yes	yes	yes	yes	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)	√		√		√
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces	√				
Key					
Knife (Knives)			√		
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)				√	√
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)				√	√
Trefoil Brooch					
Tweezers					
Arrow(s)	√				
Axe(s)					
Shield Boss	?		√		
Spear(s)					
Sword	√	√	√		
Adze					
Balance Weights	?				
Boat	√				
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					?
Pumice					
Shears (Iron)					
Sickle					√
Spindle Whorl(s)					√
Strike-a-Light					
Weaving Sword				?	
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	5	1	4	2	5

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Westray	Westray	Westray	Westray	Westray
Grave	Pierowall 4	Pierowall 6	Pierowall 7	Pierowall 8	Pierowall 9
Quality of Evidence	c	c	c	c	c
Period (As Published)	VA1?	VA1?	VA1?	VA1?	VA1?
References	Shetelig 1945:6; Thorsteinsson 1968:166	Shetelig 1945:6; Thorsteinsson 1968:167	Shetelig 1945:6; Thorsteinsson 1968:167	Shetelig 1945:6; Thorsteinsson 1968:167-8	Shetelig 1945:6; Thorsteinsson 1968:168
Skeleton Present	yes	yes	yes	yes	yes
Osteological Sex					
Osteological Age					
Grave Location	sand links	sand links	sand links	sand links	sand links
Grave-Goods	yes	yes	yes	yes	no
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)	√				
Bell					
Bronze Box					
Buckle(s)			√		
Comb(s)	√				
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)				√	
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)	√				
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)	√				
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)		√			
Shield Boss		√			
Spear(s)					
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)		√	√		
Dog Bones			√		
Horse Bones			√	√	
Horse Bridle-Bit			√	√	
Coin					
No. of Grave-good Categories	4	3	5	3	0

Region	Orkney	Orkney	Orkney	Orkney	Orkney
Island	Westray	Westray	Westray	Westray	Westray
Grave	Pierowall 10	Pierowall 11	Pierowall 12	Pierowall 13	Pierowall 13
Quality of Evidence	c	c	c	c	c
Period (As Published)	VA1?	VA1?	VA1?	VA1?	VA1?
References	Shetelig 1945:6; Thorsteinsson 1968:168	Shetelig 1945:6; Thorsteinsson 1968:168-9	Shetelig 1945:6; Thorsteinsson 1968:169	Shetelig 1945:6; Thorsteinsson 1968:169	Shetelig 1945:6; Thorsteinsson 1968:169
Skeleton Present	yes	yes	yes	yes	yes
Osteological Sex					
Osteological Age			"small"		"small"
Grave Location	sand links	sand links	sand links	sand links	sand links
Grave-Goods	yes	yes	yes	?	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)	√				
Bell					
Bronze Box					
Buckle(s)					
Comb(s)	√		√		√
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)		√	√		√
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)		√			
Ringed Pin(s)			√		√
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss	√				
Spear(s)					
Sword	√				
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone	√				
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)	√	√			
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	6	3	3	0	3

Region	Orkney	Orkney	Orkney	Orkney
Island	Westray	Westray	Westray	Westray
Grave	Pierowall 14	Pierowall 15	Pierowall 16	Pierowall 17
Quality of Evidence	c	c	c	c
Period (As Published)	VA1?	VA1?	VA1?	VA1?
References	Shetelig 1945:6; Thorsteinsson 1968:169	Shetelig 1945:6; Thorsteinsson 1968:170	Shetelig 1945:6; Thorsteinsson 1968:170-1	Shetelig 1945:6; Thorsteinsson 1968:171
Skeleton Present	yes	yes		yes
Osteological Sex				
Osteological Age	"small"			
Grave Location	sand links	sand links	sand links	sand links, in sand-hill
Grave-Goods	yes	yes	yes	yes
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				√
Comb(s)	√			
Dice				
Drinking Horn Terminal			√	
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key			√	
Knife (Knives)			√	
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)	√			
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)	√			
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)		√		
Shield Boss		√		
Spear(s)		√		
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle			√	
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)			√	√
Unidentified Iron Object(s)			√	√
Dog Bones				
Horse Bones				√
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	3	3	6	4

Region	Caithness	Caithness	Caithness	Caithness	Caithness
Island					
Grave	Castletown	Haimar	Huna	John O' Groats no. 15	John O' Groats no. 17
Quality of Evidence	c	e	c	a	a
Period (As Published)	VA	VA	VA?	LN1	LN1
References	Batey 1993b:150-1	Batey 1993b:151-2	Batey 1993b:152	Driscoll 1990:29-37	Driscoll 1990:29-37
Skeleton Present			yes	yes	yes
Osteological Sex				?	male
Osteological Age				adult	mature adult
Grave Location	top of broch			flat cemetery	flat cemetery
Grave-Goods	yes	yes	yes	no	no
Armlet (Iron)					
Armlet (Jet)	√				
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)	√				
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss					
Spear(s)					
Sword		√			
Adze					
Balance Weights					
Boat			?		
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)			√		
Unidentified Iron Object(s)			√		
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	2	1	2	0	0

Region	Caithness	Caithness	Caithness	Caithness	Caithness
Island					
Grave	John O' Groats no. 19	John O' Groats no. 23	Mill of Watten	Murkle Bay	Murkle Bay
Quality of Evidence	a	a	c	a	a
Period (As Published)	LN1	LN1	VA	LN2	LN2
References	Driscoll 1990:29-37	Driscoll 1990:29-37	Batey 1993b:151	Batey 1993b:160-161; Fojut 1987:25	Batey 1993b:160-161; Fojut 1987:25
Skeleton Present	yes	yes	yes	yes	yes
Osteological Sex	male	male?		male	female
Osteological Age	mature adult	mature adult		adult	adult
Grave Location	flat cemetery	flat cemetery		flat cemetery	flat cemetery
Grave-Goods	no	no	yes	no	no
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)					
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					
Shield Boss					
Spear(s)			√		
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	0	0	1	0	0

Region	Caithness	Caithness	Caithness	Caithness	Caithness
Island					
Grave	Reay	Reay	Reay	St. Peter's Church-yard	Thurso East
Quality of Evidence	c	c	c	a	e
Period (As Published)	VA	VA	VA2	LN1	VA
References	Batey 1993b:152	Batey 1993b:153	Batey 1993b:152; Shetelig 1945:7	Batey 1993b:157	Batey 1993b:158-9
Skeleton Present	yes			yes	
Osteological Sex					
Osteological Age					
Grave Location	cemetery	cemetery, on paved surface	cemetery	church-yard	
Grave-Goods	yes	yes	yes	no	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)	√	√	√		
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)		√			
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)			√		√
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)		√	?		
Trefoil Brooch					
Tweezers			?		
Arrow(s)					
Axe(s)		√			
Shield Boss		√			
Spear(s)					
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle		√			
Spindle Whorl(s)			√		
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone		√			
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit	√		√		
Coin					
No. of Grave-good Categories	2	7	4	0	1

Region	Caithness	Sutherland	Sutherland	Sutherland	Sutherland
Island					
Grave	Westerseat	Balnakeil	Dunrobin	Dunrobin IL209	Dunrobin Shore
Quality of Evidence	c	b	c	e	e
Period (As Published)	VA	VA	VA2	VA?	VA
References	Batey 1993b:151	Batey 1993b:157-8; Powell et al. 1991:46	Batey 1993b:155; Shetelig 1945:8	Batey 1993b:155	Batey 1993b:155
Skeleton Present		yes			
Osteological Sex		male			
Osteological Age		8-13			
Grave Location	in "gravel hillock"	coastal dunes			shore
Grave-Goods	yes	yes	yes	yes	yes
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)		√			
Bell					
Bronze Box					
Buckle(s)					
Comb(s)		√			
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces		√			
Key					
Knife (Knives)					
Mount(s) or Strap End(s)		?			
Necklet (iron)					
Oval Brooch(es)	√		√		
Penannular Brooch(es)		√			
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)					√
Shield Boss		√			
Spear(s)		√		√	
Sword		√			
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)		√			
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					√
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	1	8	1	1	2

Region	Sutherland	Sutherland
Island		
Grave	Keodale	Ospisdale
Quality of Evidence	e	e
Period (As Published)	VA?	VA
References	Batey 1993b:155-6	Batey 1993b:155
Skeleton Present		
Osteological Sex		
Osteological Age		
Grave Location		
Grave-Goods	yes	yes
Armlet (Iron)		
Armlet (Jet)		
Armlet (Silver)		
Bead(s)		
Bell	√	
Bronze Box		
Buckle(s)		
Comb(s)		
Dice		
Drinking Horn Terminal		
Ear-Rings (Bronze & Silver)	√	
Egual-Armed Brooch		
Gaming Pieces		
Key		
Knife (Knives)		
Mount(s) or Strap End(s)		
Necklet (iron)		
Oval Brooch(es)		√
Penannular Brooch(es)		
Pin(s) or Brooch(es) (Bronze)	√	
Ringed Pin(s)		
Trefoil Brooch		
Tweezers		
Arrow(s)		
Axe(s)		
Shield Boss		
Spear(s)		
Sword		
Adze		
Balance Weights		
Boat		
Bronze Vessel		
Fishing Weight		
Hackle(s) (Iron)		
Linen Smoother (Glass)		
Loom Weight(s)		
Needle(s)		
Pumice		
Shears (Iron)		
Sickle		
Spindle Whorl(s)		
Strike-a-Light		
Weaving Sword		
Whale Bone Plaque		
Whetstone		
Nail(s)/Rivet(s)		
Unidentified Iron Object(s)		
Dog Bones		
Horse Bones		
Horse Bridle-Bit		
Coin		
No. of Grave-good Categories	3	1

Region	Shetland	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland	Mainland
Grave	St. Olaf's Churchyard	Upper Scalloway 1	Upper Scalloway 2	Upper Scalloway 3	Upper Scalloway 4
Quality of Evidence	d	a	a	a	a
Period (As Published)	VA1	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Shetelig 1945:4	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present		yes	yes	yes	yes
Osteological Sex		female	male	?	female
Osteological Age		adult	adult	?	adult
Grave Location	churchyard	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	yes	no	no	no	no
Armlet (Iron)					
Armlet (Jet)					
Armlet (Silver)					
Bead(s)					
Bell					
Bronze Box					
Buckle(s)					
Comb(s)					
Dice					
Drinking Horn Terminal					
Ear-Rings (Bronze & Silver)					
Egual-Armed Brooch					
Gaming Pieces					
Key					
Knife (Knives)					
Mount(s) or Strap End(s)					
Necklet (iron)					
Oval Brooch(es)					
Penannular Brooch(es)					
Pin(s) or Brooch(es) (Bronze)					
Ringed Pin(s)					
Trefoil Brooch					
Tweezers					
Arrow(s)					
Axe(s)	√				
Shield Boss					
Spear(s)					
Sword					
Adze					
Balance Weights					
Boat					
Bronze Vessel					
Fishing Weight					
Hackle(s) (Iron)					
Linen Smoother (Glass)					
Loom Weight(s)					
Needle(s)					
Pumice					
Shears (Iron)					
Sickle					
Spindle Whorl(s)					
Strike-a-Light					
Weaving Sword					
Whale Bone Plaque					
Whetstone					
Nail(s)/Rivet(s)					
Unidentified Iron Object(s)					
Dog Bones					
Horse Bones					
Horse Bridle-Bit					
Coin					
No. of Grave-good Categories	1	0	0	0	0

Region	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland
Grave	Upper Scalloway 5	Upper Scalloway 6	Upper Scalloway 7	Upper Scalloway 8
Quality of Evidence	a	a	a	a
Period (As Published)	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present	yes	yes	yes	yes
Osteological Sex	female	male	male	male
Osteological Age	adult	adult	adult	adult
Grave Location	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	no	no	no	no
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				
Comb(s)				
Dice				
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)				
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)				
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)				
Shield Boss				
Spear(s)				
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle				
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)				
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	0	0	0	0

Region	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland
Grave	Upper Scalloway 9	Upper Scalloway 10	Upper Scalloway 11	Upper Scalloway 12
Quality of Evidence	a	a	a	a
Period (As Published)	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present	yes	yes	yes	yes
Osteological Sex	?	?	male	male
Osteological Age	c.8	?	adult	adult
Grave Location	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	no	no	no	no
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				
Comb(s)				
Dice				
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)				
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)				
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)				
Shield Boss				
Spear(s)				
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle				
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)				
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	0	0	0	0

Region	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland
Grave	Upper Scalloway 13	Upper Scalloway 14	Upper Scalloway 15	Upper Scalloway 16
Quality of Evidence	a	a	a	a
Period (As Published)	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present	yes	yes	yes	yes
Osteological Sex	female	female	?	female
Osteological Age	adult	adult	<2	adult
Grave Location	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	yes	no	no	no
Armlet (Iron)	√			
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				
Comb(s)				
Dice				
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)				
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)				
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)				
Shield Boss				
Spear(s)				
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle				
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)				
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	1	0	0	0

Region	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland
Grave	Upper Scalloway 17	Upper Scalloway 18a	Upper Scalloway 18b	Upper Scalloway 19
Quality of Evidence	a	a	a	a
Period (As Published)	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present	yes	yes	yes	yes
Osteological Sex	female	?	female	?
Osteological Age	adult	<2	adult	?
Grave Location	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	no	no	no	no
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				
Comb(s)				
Dice				
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)				
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)				
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)				
Shield Boss				
Spear(s)				
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle				
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)				
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	0	0	0	0

Region	Shetland	Shetland	Shetland	Shetland
Island	Mainland	Mainland	Mainland	Mainland
Grave	Upper Scalloway 20	Upper Scalloway 21	Upper Scalloway 22	Upper Scalloway 23
Quality of Evidence	a	a	a	a
Period (As Published)	LN2-PM	LN2-PM	LN2-PM	LN2-PM
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68
Skeleton Present	yes	yes	yes	yes
Osteological Sex	male	female	male	?
Osteological Age	adult	adult	adult	?
Grave Location	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound	cemetery, in Iron Age mound
Grave-Goods	no	no	no	no
Armlet (Iron)				
Armlet (Jet)				
Armlet (Silver)				
Bead(s)				
Bell				
Bronze Box				
Buckle(s)				
Comb(s)				
Dice				
Drinking Horn Terminal				
Ear-Rings (Bronze & Silver)				
Egual-Armed Brooch				
Gaming Pieces				
Key				
Knife (Knives)				
Mount(s) or Strap End(s)				
Necklet (iron)				
Oval Brooch(es)				
Penannular Brooch(es)				
Pin(s) or Brooch(es) (Bronze)				
Ringed Pin(s)				
Trefoil Brooch				
Tweezers				
Arrow(s)				
Axe(s)				
Shield Boss				
Spear(s)				
Sword				
Adze				
Balance Weights				
Boat				
Bronze Vessel				
Fishing Weight				
Hackle(s) (Iron)				
Linen Smoother (Glass)				
Loom Weight(s)				
Needle(s)				
Pumice				
Shears (Iron)				
Sickle				
Spindle Whorl(s)				
Strike-a-Light				
Weaving Sword				
Whale Bone Plaque				
Whetstone				
Nail(s)/Rivet(s)				
Unidentified Iron Object(s)				
Dog Bones				
Horse Bones				
Horse Bridle-Bit				
Coin				
No. of Grave-good Categories	0	0	0	0

Region	Shetland	Shetland	Shetland
Island	Mainland	Unst	Unst
Grave	Upper Scalloway 24	NMS IL313-14, Unst	Clibberswick
Quality of Evidence	a	c	c
Period (As Published)	LN2-PM	VA1	VA2
References	Sharples 1990:48; Lorimer n.d; Smith & Turner 1989:68	Grieg 1940:103; Shetelig 1945:4	Grieg 1940:103-5; Shetelig 1945:47
Skeleton Present	yes		
Osteological Sex	female		
Osteological Age	adult		
Grave Location	cemetery, in Iron Age mound		
Grave-Goods	no	yes	yes
Armlet (Iron)			
Armlet (Jet)			
Armlet (Silver)			√
Bead(s)			√
Bell			
Bronze Box		√	
Buckle(s)			
Comb(s)			
Dice			
Drinking Horn Terminal			
Ear-Rings (Bronze & Silver)			
Egual-Armed Brooch			
Gaming Pieces			
Key			
Knife (Knives)			
Mount(s) or Strap End(s)			
Necklet (iron)			
Oval Brooch(es)		√	√
Penannular Brooch(es)			
Pin(s) or Brooch(es) (Bronze)			
Ringed Pin(s)			
Trefoil Brooch			√
Tweezers			
Arrow(s)			
Axe(s)			
Shield Boss			
Spear(s)			
Sword			
Adze			
Balance Weights			
Boat			
Bronze Vessel			
Fishing Weight			
Hackle(s) (Iron)			
Linen Smoother (Glass)			
Loom Weight(s)			
Needle(s)			
Pumice			
Shears (Iron)			
Sickle			
Spindle Whorl(s)			
Strike-a-Light			
Weaving Sword			
Whale Bone Plaque			
Whetstone			
Nail(s)/Rivet(s)			
Unidentified Iron Object(s)			
Dog Bones			
Horse Bones			
Horse Bridle-Bit			
Coin			
No. of Grave-good Categories	0	2	4

Appendix 5.1

Faunal and botanical assemblages for which data were available at the time of writing

(in geographical order, from north to south, within each region)

Orkney:

St. Boniface, Papa Westray

Excavated Norse deposits (phase 8) at St. Boniface have been radiocarbon dated to the 11th-13th centuries (Lowe 1993:30). It is tempting to characterise the site as LN1, but a caveat must be added that some deposits could date to LN2. The relevant strata, described as a 'farm mound', are middens dominated by ash and fish bone. They lie on the west coast of the small northern Orcadian island, Papa Westray.

Bone was recovered by sieving all sediment with 1mm mesh (Cerón-Carrasco 1994:207). Not untypically, analytical strategies varied by class. All fish specimens were enumerated, although some elements were only routinely identified to the level of family or class (Cerón-Carrasco forthcoming). Similarly, all bird bone fragments were counted (Hamilton-Dyer forthcoming; pers comm.). The treatment of mammals differed as there is no available record of unidentified fragments (McCormick forthcoming). Inter-class comparisons are therefore problematic.

Botanical remains were also systematically recovered at St Boniface. However, results from post-excavation analysis were not available at the time of writing (Lowe pers comm.).

Quoygrew, Westray

Sarah Colley's (1983a:208-217) excavations at Quoygrew focused on middens rich in fish bone stretched along the shore of Rack Wick, a northwest facing bay on the island of Westray. The middens contained an indeterminate stone structure (possibly the remains of a drain), 'Norse' pottery, shell, mammal bone, bird bone and carbonised vegetation (Colley 1983a:209-212). They were broadly dated to the "Norse period" by "two worked bone objects" and "a few pieces of pottery" (Colley 1983a:209). Although close dating of this site remains a priority for the future, the presence of pottery could imply that it was occupied during the Late Norse Period rather than the Viking Age. As mentioned in Chapter 3 above, the Viking Age was largely aceramic in Orkney, Caithness and Shetland.

Bone recovery was ideal at Quoygrew, with all sediment sieved to 1.5mm (Colley 1983a:209). Regrettably, however, only the fish bone was analysed. The analytical procedure for this assemblage was as follows. Specimens from taxa other than the cod family were identified to element and to the finest possible taxonomic level. For members of the superabundant Gadidae family, however, only 16 diagnostic elements were identified to species (Colley 1983a:198). These are the otolith, vomer, parasphenoid, premaxilla, maxilla, dentary, articular, preopercular, palatine, quadrate, hyomandibular, ceratohyal, cleithrum, posttemporal, supracleithrum and vertebra. Other cod family elements were either classed as 'unknown/gadoid' (branchiostegals, fin rays and spines) or as skeletal groups (cranial bones, branchial bones, facial bones) at the level of family (Colley 1983a:190, 198). This strategy will not affect analyses at the family level. However, comparisons below the level of family could underestimate the importance of gadoid fishes.

Tuquoy, Westray

Tuquoy lies on the south coast of Westray, at the Ness of Tuquoy. Excavations by Olwyn Owen (1993) have focused on a Viking Age pit (Area J) and on middens and structures spanning LN1 and LN2 (Area F). The structures of Area F, excavated predominately in 1982-1983, included a LN1 hall and rectilinear buildings of LN2 date (Owen 1993:327, 329). Rubbish deposits yielding bone and charred botanical material cannot be dated more closely than the Late Norse Period until publication of final phasing information. However, they are probably broadly contemporary with the structural evidence.

Carbonised botanical remains from Area F were retrieved using 1mm mesh (Nye & Boardman n.d.). Bone was recovered by a combination of hand collecting and sieving using 5mm or 1mm mesh, possibly from the same samples sieved for botanical macrofossils (although this is not made explicit in the available reports). The proportion of each layer sieved varied from none to c.33% (Colley 1988). Although all classes of bone have received preliminary analysis (Owen pers comm.), data are only currently available for bird (Hamilton-Dyer 1991) and fish (Colley 1983a:229-235; 1988).

The fish assemblage must be divided into two distinct data sets. Bones from the 1982 excavation season were analysed following a system identical to that used at Quoygrew (see Colley 1983a:341-342). Conversely, a report combining data from all excavation seasons up to (but not including) 1988 does not tabulate the results by skeletal element (Colley 1988). Thus, the 1982 data are used to study the relative distribution of different body parts (see Section 1.3.3, Table 1.1 and Figure 1.4) while the combined assemblage is considered for all other purposes (Section 5.6, Table 5.6). It is also relevant to note that, as at Quoygrew, only a selection of distinctive gadoid elements (17 in this case) were routinely identified to species (Colley 1988). Inter-taxon comparisons below the level of family could thus underestimate the importance of cod family fishes.

Area J, the Viking Age pit, was excavated in 1988. It yielded an assemblage of waterlogged botanical remains, including possible household and byre waste and offcuts from wood timbers (Crone n.d.; Owen 1993:330; Jones n.d.; Nye & Boardman n.d.; Tipping n.d.). In addition to hand retrieval of preserved wood, four 1kg bulk samples were taken from the pit and sieved using 0.25mm or 0.5mm mesh to recover waterlogged seeds and fibers. Two (60g) samples from a soil monolith were also sieved to 0.25mm (Jones n.d.). Quantitative data are available for the resulting assemblage (Crone n.d.; Jones n.d.; Nye & Boardman n.d), but are not comparable with 'seed' counts from other sites where preservation was by charring. The taxa represented in Area J are thus tabulated as presence data in Table 5.8. The reader is referred to Owen's (1993) preliminary report regarding excavations at Tuquoy for more detailed consideration of this uncommonly well preserved deposit.

Pool, Sanday

Two phases of Norse middens and structures have been identified at Pool, a settlement mound eroding into a bay of the same name on the island of Sanday. An 'interface' phase (seven) yielded a mixture of Iron Age (Pictish) and Viking Age material culture and radiocarbon assays spanning the 8th-9th centuries (Hunter et al. 1993:280-281). The overlying Norse phase (eight) is dated to the subsequent two or three hundred years, also by artifacts and ^{14}C analysis (Hunter pers comm.). For purposes of inter-site comparison these phases are categorised as VA1 and VA2-LN1 respectively.

The vast majority of bone from Pool was hand collected (Nicholson n.d.b). Some sieving was conducted using 10mm and 3mm mesh. However, given that 12095 fish specimens were recovered by hand collecting and only 869 by sieving it is safe to assume that the degree of controlled recovery was minimal (Nicholson n.d.b). Mammal (Bond 1994; Bond et al. forthcoming) and bird (Serjeantson forthcoming) bones were identified to the smallest possible taxonomic category and quantified as fragment counts. Fish bone was similarly treated, with the caveat that some elements from the dominant group, Gadidae, were not identified beyond the level of family (Nicholson n.d.b:5-6). As with the Tuquoy and Quoygrew assemblages, the importance of cod family fishes could be slightly underestimated by inter-species comparisons.

The botanical assemblage from Pool was recovered by flotation of 123 samples (totaling 1806 litres of sediment) onto 0.5mm mesh. The samples analysed were chosen to represent a wide variety of feature types - including middens, occupation surfaces and hearths (Bond 1994: Section 6.2.2, Section 6.2.5). The data have been tabulated by ubiquity (the number of samples in which a given taxon occurs) rather than 'seed' count (Bond 1994:Appendix A). Thus, only the presence or absence of taxa is recorded in Table 5.8.

Brough of Birsay Room 5, Mainland

A number of excavations have been carried out over the last 60 years at the Norse elite or ecclesiastical complex on the Brough of Birsay (see Curle 1982:12-17). However, the first systematic recovery of faunal and botanical samples began in 1973-1974 with the excavation of Room 5 (Hunter & Morris 1982). This project focused on the interior, walls and immediate exterior of a single structure. The chronological context of the Norse occupation layers (3a, 3b and 4) is slightly ambiguous. A single calibrated radiocarbon date is available for phase 3a, A.D. 915-1075 (one sigma range) (Renfrew & Buteux 1985:274). There is no dating evidence for phase 3b, but steatite cooking vessel fragments and a steatite spindle whorl place phase 4 in a Norse context (Hunter and Morris 1982:129, 131). It is probably appropriate to date the entire occupation to VA2.

Most bone was recovered from fill layers which separated the occupation surfaces in the room. Less bone-rich features included floor accumulations, exterior ground surface deposits, and structural (wall) deposits (Hunter and Morris 1982:124-127). Some sediment was wet sieved through 5mm mesh (Donaldson et al. 1981:75), but no mention is made of the quantity processed. Published details regarding analytical methods are brief, but both unidentified and identified specimens were quantified as percentages based on fragment counts (Seller 1982:Tables 1-2). Absolute fragment count data (see Tables 5.5-5.7) have been back-calculated using these percentages and the total sample size by phase. Birds were identified to class and only three fish taxa were noted. Given the diversity of fishes in other assemblages from the earldoms, it is likely that many bones of this class are represented as unidentified fragments. Unidentified mammal and fish are not differentiated, making inter-class comparisons meaningless for this assemblage.

Charcoal samples from the VA2 phases of Room 5 have also been analysed (Donaldson 1982:138). The recovery strategy is not explained, but some botanical material may have derived from the samples sieved to 5mm for bone recovery.

Brough of Birsay Sites VII-IX, Mainland

Between 1974 and 1982 three areas of eroding cliff-side on the Brough of Birsay were excavated by John Hunter (1986). This work revealed two Norse phases of mixed domestic, farm and industrial activity. The sites consisted of a wide variety of interior and exterior feature types: floor accumulations, ground surfaces, hearths, pits, structural remains (e.g. wall fill), and refuse deposits (Hunter 1986:69-102; 118-141).

The Norse phases (2 and 3) are attributed to the 9th-10th centuries (VA2) and 11th-12th centuries (LN1) respectively (Hunter 1986:103-105, 142-143, 176-177). Although three 'sites' were excavated, within each phase they were broadly contemporary portions of a single settlement (Hunter 1986:107, 142-143). This factor, combined with the small size of faunal and botanical samples from each area, justifies combining the three assemblages by phase.

Faunal remains were recovered by a combination of hand collecting and sieving through 5 mm mesh (Hunter 1986:22). Hunter did not, however, publish details regarding which contexts were sieved for bones. Flotation samples were collected by judgment from "all major burnt contexts" (Donaldson 1986a:216-217) and it is possible that the same samples were processed to recover bone fragments.

Faunal material was quantified following a strategy similar to that used for Room 5 (Seller 1986). For the present study, percentage abundance and total sample size data (Seller 1986:Tables 10, 11, 18, 25) have once again been used to calculate fragment counts. Unlike the Room 5 report, however, Seller's study of the faunal assemblage from Sites VII-IX quantifies fish at the level of class. As this category is likely to include unidentified fish specimens, inter-class comparisons may be more valid than was the case with the previous assemblage. Bird bones were also identified to class (although goose was noted specifically in one area), suggesting that all other unidentified fragments (which can be calculated from Seller's table 10) were of mammal bone.

A cautionary note regarding Seller's report is apropos at this point. As Rackham (1989:MF4G6) observes, specimens identified as hare are more likely to be rabbit. The latter taxa is ubiquitous in Orcadian faunal assemblages (see Table 5.5), probably often due to intrusive burrowing. With the exception of the mountain hare, restricted to Hoy, the hare is thought to have been introduced to Orkney c.1830 (Berry 1985:131).

As mentioned above, samples for recovery of botanical macrofossils were collected by judgment from "all major burnt contexts" (Donaldson 1986a:216-217). These largely consisted of burned areas of house floor, presumably associated with hearths, and refuse deposits (Hunter 1986; Donaldson 1986a). Wet conditions prompted the use of paraffin flotation to ensure adequate recovery of temporarily waterlogged botanical material (see Donaldson 1986a:216-217). A 300 micron sieve was used to recover the resulting light fraction (Donaldson 1986a:217).

Buckquoy, Mainland

Buckquoy (Ritchie 1976-1977) was the first of several Norse sites on Birsay Bay (opposite the elite or ecclesiastical settlement on the Brough) to have been excavated in recent decades. The others, Brough Road Areas 1 and 2, Beachview Burnside Area 2, Beachview Studio Site and Saevar Howe, are discussed below. At Buckquoy, three superimposed structures (phases III, IV and V) constituted the Norse occupation. Features included a midden, floor deposits, a paved exterior surface and a plow zone (which may have been a heavily disturbed midden) (Ritchie 1976-1977:184-185, 186, 188). They have been broadly dated to the Viking Age on the basis of architectural and artifactual evidence (Ritchie 1976-1977:186-188, 192). In particular, a grave dug into the occupation phases included a ringed pin and a deliberately cut silver penny of Eadmund (AD 940-6). These suggest a tenth-century date for the burial and an earlier date for the occupation horizon (Ritchie 1976-1977:190).

All of the bones from Buckquoy were recovered by hand collecting (Wheeler 1976-1977:211). Interpretation is further hampered by the fact that only MNI estimates are available for the fish assemblage (Wheeler 1976-1977), only fragment count data exist for the bird bone (Bramwell 1976-1977) and both MNI and count data are available for the mammal assemblage (Noddle 1976-1977). Confronted with this inconsistency, it was decided to quantify only the mammal and bird bones - by fragment count - and to simply indicate the presence of fish taxa. This seemed the best solution given that the fish assemblage was probably also severely affected by recovery biases (see Section 5.2.2).

Botanical remains were not systematically collected at Buckquoy. However, a sample of silty material from a drain in house 3 (interpreted as a byre) yielded plant cells resembling those from grasses (Ritchie 1976-1977:185).

Brough Road Areas 1 and 2, Mainland

Brough Road Areas 1 and 2 were adjacent excavation units south of Buckquoy on the shore of Birsay Bay (Morris 1989). Palaeoeconomic evidence derives predominantly from middens, but was also collected from the fill of two graves and from two phases of a flag-stone surface (Morris 1989:127, 141-142). The deposits considered here (phases D, E and F1 in Area 1 and phases B1, B2, C1, C2 and D in Area 2) are essentially dated to the Viking Age with the possibility of some earlier accumulation in the late Pictish period (Morris 1989:118, 123, 127, 141-142; Morris et al. 1989:298-299, Table 33).

Bones from Area 1 were recovered by hand from all excavated contexts. Small sub-samples were removed from one midden layer in Phase D for sieving using a sequence of mesh sizes ranging from 2.00 mm to 0.85 mm. The samples were chosen by judgment to avoid rabbit burrows (Rackham 1989:232). The quantity of material sieved is not published, but given the restriction to a single layer it is unlikely to constitute a significant proportion of the sediment excavated.

In Area 2, bones were also removed by hand from all excavated contexts. One layer in Phase C1 and two layers in Phase C2 were also sub-sampled for sieving. Some were sieved through 1 cm mesh at the site. Others were passed through a sequence of sieves ranging from 2.00 mm to 0.85 mm in aperture. The samples were chosen to provide relatively even coverage of the excavated area. The location of rabbit burrows, however, limited the choice of undisturbed areas to sample (Rackham 1989:232). The quantity of sediment sieved is not recorded.

Faunal data from Areas 1 and 2 were tabulated as fragment counts (Allison 1989; Colley 1989; Rackham 1989). There is no published indication that mammal and bird bones were not identified to the smallest taxonomic category possible. Colley's (1989) fish bone analysis, however, followed a strategy similar to that used for Quoygrew and Tuquoy. All bones from families other than Gadidae were identified to the finest possible taxonomic division. Twenty elements were so treated for gadoid fishes, with the remainder identified only by element (or skeletal group such as cranial, facial and branchial bones) and family (Colley 1989:MFIVA9). While inter-class and inter-family comparisons remain uncomplicated, this approach could bias the relative abundance of single gadoid species in relation to taxa from other families.

Area 2 also produced a substantial botanical assemblage. Systematic sampling of designated excavation units was employed concurrent with judgment sampling of areas which had been too disturbed by rabbits to risk arbitrary collection. The botanical samples were processed by a combination of on-site flotation (no mesh size published) and laboratory wet sieving (0.85 mm mesh) or dry sieving (0.895 mm mesh) (Rackham 1989:232). Like the bone assemblage, they derived from midden contexts (phases C1 and C2 only) attributed to the Viking Age (Donaldson and Nye 1989:262, 266; Rackham 1989:232).

Beachview Burnside Area 2, Mainland

Burnside Area 2 is one of two excavations at the Beachview site to have produced a substantial and well dated ecofactual assemblage. It lies on the south bank of Boardhouse burn near the shore of Birsay Bay (Morris forthcoming a). Two phases of midden deposition, W and X, have been dated to the Late Norse Period, probably LN1, based on radiocarbon assays, steatite vessel fragments and comb fragments (Morris forthcoming a).

Bone was recovered by a combination of sieving and hand collecting. All sediment from four $1m^2$ sample units, distributed systematically over an 8m x 4m excavation area, was wet sieved through 0.895mm mesh. Bone was predominately hand collected from the remainder of the trench, but small judgmental samples were also occasionally sieved. In total, c.12.5% of the excavated sediment was sampled for systematic recovery of faunal (and botanical) remains (Rackham et al. forthcoming a). Bones from the sieved and unsieved fractions were kept separate, and are presented as distinct data sets in Tables 5.5-5.7.

In the absence of indications to the contrary (Rackham et al. forthcoming a), it is assumed that all mammal and bird specimens were identified to the finest possible taxonomic category. Colley's (in Rackham et al. forthcoming a) analysis of the fish bone followed the strategy used at Brough Road Areas 1 and 2 (Colley 1989:MFIVA9; see above), with the additional caveat that the number of fin rays, spines and unidentified fragments were estimated based on the count and volume represented in a subsample.

Botanical remains from Beachview Burnside Area 2 were recovered by submerging residue from the 0.895mm mesh in water and decanting floating material onto 0.3mm mesh (Rackham et al. forthcoming a).

Beachview Studio Site, Mainland

Excavations at the Beachview Studio Site focused on a Late Norse dwelling, including a probable corn drying kiln, and associated (contemporary and overlying) midden deposits. The building lay less than 100m south of Beachview Burnside Area 2 and c.50m from the shore. All phases considered here (K-Y inclusive in Area 1, Q-W inclusive in Sub-areas D/E) can probably be dated to LN1 on the basis of radiocarbon assays, steatite vessel sherds, antler comb fragments and a bone pin (Morris forthcoming a). It should be kept in mind, however, that the two sigma range of some radiocarbon assays included the 13th and 14th centuries (Morris forthcoming a).

For ease of interpretation it is necessary to consider bone from the Studio Site as two distinct data sets. Unsieved material from sub-areas D/E - outwith the dwelling - and Area 1 - the dwelling - constitute one assemblage (Rackham et al. forthcoming b; forthcoming c). The second assemblage, from selected phases of Area 1, includes only material sieved using 0.895mm mesh.* Unlike at Burnside Area 2, the sampling strategy was judgmental rather than systematic (Rackham et al. forthcoming b; forthcoming c; forthcoming d).

Methods of zooarchaeological analysis were the same at both Beachview sites. Similarly, botanical material from the Studio Site was collected from the sieved samples of Area 1 following the same procedures used at Burnside Area 2 (Rackham et al. forthcoming b; forthcoming c). For the Studio Site assemblage, however, the number of cereal grains in large samples was estimated rather than quantified. This site is thus left out of quantitative comparisons attempted in Section 5.4.

Saevar Howe, Mainland

Saevar Howe is a settlement mound on the south side of Birsay Bay, c.750m south of the Beachview Studio Site (Hedges 1983). Phases IIa, IIb and IIc included structures, floor accumulations, middens and exterior ground surfaces dated to the Viking Age by associated artifacts and radiocarbon assays (Batey & Morris 1983:107; Hedges

*Note that specimens recovered in an insignificant number of sieved samples from sub-areas D/E are not considered as they simply complicate the data set.

1983:82-85; Stenhouse & Hedges 1983:108-109). Ecofactual remains were recovered during rescue excavations in 1977. Norse areas of the site had also been excavated in the 19th century, but faunal remains were not saved (Hedges 1983:73-77).

Bones were recovered by hand collecting and by sieving all soil through 5 mm mesh (Colley 1983c:112, 1984:121). All fish bones have been quantified, with the caveat that only a selection of 10 Gadidae elements were routinely identified to species. The remainder were attributed to family and element (or skeletal group) (Colley 1983c:MF 95, MF Table 13) However, only mammal and bird specimens which could be identified to genus or species have been published (Rowley-Conwy 1983:MF Table 1). It is thus difficult to use this assemblage for meaningful inter-class comparisons.

Samples for the recovery of botanical remains were taken from the floor deposits of two superimposed domestic buildings (Phases IIb and IIc) (Hedges 1983:120). The floors consisted of packed sand mixed with an accumulation of refuse and carbon (Hedges 1983:82-85,119). There is no mention of flotation procedures in the site report. However, the 5mm sieves used to recover other remains (Colley 1983c:112) would probably not have retained the seeds recorded in Table 5.8. Some flotation or fine-mesh recovery technique was presumably used, but the data should be treated cautiously.

Brough of Deerness, Mainland

Excavation of a chapel and associated enclosure at the elite or ecclesiastical settlement on the Brough of Deerness produced a small assemblage of bones and charcoal (Donaldson 1986c;Rackham 1986). Phases of construction, use and collapse at the site span a period from at least the Viking Age to the 20th century (Morris & Emery 1986:357). For present purposes, phases A1-B2 are considered Viking Age and phases C1-D1 Late Norse in date. This is not inconsistent with most dating evidence from the site, but one radiocarbon assay could imply that phase A belongs to an earlier Pictish occupation (Morris & Emery 1986:356-367).

The faunal assemblage is not particularly informative. Although three samples were sieved (using various mesh sizes), producing a small quantity of burnt bone, the faunal assemblage was essentially all hand collected (Morris & Emery 1986:MF4 D1-D3; Rackham 1986:348). Moreover, the sample size in each phase is tiny (Rackham 1986:MF Table 6, Table 7, Table 8). Most importantly, primary rubbish is perhaps unlikely to accumulate in and around a chapel during its original use. Even after it went out of use, the structure does not seem to have become a focus for disposal of domestic or agricultural rubbish. Rackham (1986:349) suggests that much of the faunal material from later phases was introduced incidentally by birds, pilgrims, fishermen and shepherds - or by the death of animals taking shelter in the abandoned building.

The Norse botanical assemblage consists exclusively of wood charcoal, all from small branches of willow and (in a few cases) alder (Donaldson 1986c:349). These taxa, one local (willow) and the other probably driftwood (alder), add little to the economic picture revealed by other assemblages. Like bone, they are not included in the summary tables above.

Skaill, Deerness, Mainland

The site of Skaill, Deerness, constituted a series of excavated areas (revealing structures and associated middens) on the south side of Sandside Bay c.2.5km south of the Brough of Deerness (Buteux forthcoming). Interpretation of the excavations is complex, but at least Site 2 can be dated to the Viking Age with some confidence. Some phases of Site 1 may date to the Late Norse Period, but the evidence against this interpretation is considerable (see Section 3.5 above).

Analysis of the ecofactual assemblage is seriously complicated by uncertainties regarding phasing. The "Viking" phase used in Noddle's (forthcoming) mammal report includes material from Sites 2, 3 and 4. The same 'phase' in Allison's (forthcoming) bird bone report includes only Site 2 and "possibly" the "Norse levels on Site 4". Moreover, Nicholson (n.d. a) does not divide the fish bone assemblage by phase (although "most of the remains came from midden deposits associated with dwellings of Norse date.").

Further inconsistencies occur at the level of analytical methods. With the exception of elements such as fin rays, spines and branchiostegal rays Nicholson (n.d. a) attempted to identify all fish bones to the finest possible taxonomic category. However, unidentified specimens are only tabulated for the bird assemblage and rare mammal taxa are not fully recorded (Allison forthcoming: Table 19.1; Nicholson n.d. a: Table 18.1; Noddle forthcoming:Table 17.1a).

These inconsistencies, combined with the fact that the entire assemblage was hand collected (Nicholson n.d. a), make inter-class comparisons meaningless for Skaill. The data are of use, however, insofar as they reveal broad patterns of species composition and (for the mammal assemblage) age at death. No botanical report is available for this site.

Earl's Bu, Mainland

(See Section 5.3.1 above)

Caithness:

Robert's Haven

(See Section 5.3.2 above)

Freswick Links

(See section 5.3.3 above)

Freswick Castle

Excavations at Freswick Castle, on the south side of Freswick Bay, focused on midden and structural strata predating the current 17th-18th century house (Batey et al. 1984). The lack of close dating evidence has led the investigators to treat the relatively small biological assemblage as a single data set (Batey et al. 1984:109), a pattern followed here. Although some modern 'intrusive' objects (including, among other things, remains of brown rats and a turkey!) were recovered from the deposits they have been broadly dated to the Late Norse Period (Batey et al. 1984:109-110, 116).

Most bone was recovered by hand collecting (see Batey et al. 1984:MF Table III, MF Table V, MF Table VII, MF Table VIII). Only three bulk samples totaling 17kg and 12 tiny samples of 0.5kg were sieved (using 0.85 mm mesh) (Batey et al 1984:MF M195-M198). The sieved and unsieved faunal assemblages are thus combined in Tables 5.5-5.7. There is no indication that mammal and bird bones were not identified to the narrowest possible taxonomic category. However, full quantitative data are not available for fish (Batey et al. 1984:MF Table V). This latter class is thus tabulated above only by presence and absence data. Botanical remains were hand collected (charcoal only) and recovered by floatation from the three bulk samples (totaling 17kg) mentioned above (Batey et al. 1984:MF M195-M198, MF Table III; Donaldson 1984: MF M203-M204).

Shetland:

Sandwick, Unst

Excavations at Sandwick focused on a single dwelling - and four areas of associated midden deposition - on the shoreline of a bay of the same name in southeast Unst (Bigelow 1984; 1985; 1987; 1989). Occupation of the site has been divided into two phases, early and main, encompassing the 12th and 13th-14th centuries AD respectively (Bigelow 1987:30). For purposes of inter-site comparison, these phases are classified as LN1 and LN2 in the present study.

Data regarding the analysis of bone from midden units 2, 3 and 4 are presently available (Bigelow 1984:113-134, Tables 11-13). This material was recovered by a combination of hand collecting and sieving with 1.5mm or (predominately) 3mm mesh (Bigelow 1984:114). A minimum of 50% of the sediment in each midden unit was sieved.

The data are quantified as fragment counts, including all mammal and bird specimens but only a selection of diagnostic fish elements. Fish vertebrae were routinely identified to class while six cranial elements - dentaries, premaxillae, maxillae, articulars, vomers and otoliths - were identified to species (Bigelow 1984:122, Table 6). This inconsistency makes it difficult to asses the relative proportion of fish *vis-à-vis* mammals and birds.

Botanical remains were recovered at Sandwick by flotation of 6% of the sediment from midden unit 1 (Bigelow 1984:114, 135). No sieve size is recorded, but use of a 'tea strainer' to collect carbonised plant material implies that only larger objects, such as cereal grain, are likely to have been systematically retained. Preliminary analysis of the flots has revealed the presence of oats, hulled six row barley and flax (Bigelow 1984:135). Although useful as presence data, no quantitative assessment of this information is possible.

Jarlshof, Mainland

As discussed in Section 3.8, settlement at Jarlshof spanned at least VA2 to LN2. The site lies near the shore in West Voe at the southernmost extremity of the Shetland Mainland. Dwellings, outbuildings and middens were excavated, with most faunal material deriving from the latter.

Although faunal remains were not collected or analysed to modern standards, Platt's (1956) report was precocious in its qualitative assessment of the relative proportion of different taxa. Sheep and cattle were consistently numerous in both VA and LN phases while pigs were common but less abundant. Seal bones, particularly of the grey seal, were as frequent as, or even more frequent than, the remains of domestic animals. A variety of domestic and sea bird taxa were identified, but in this case little attention is given to their relative abundance. Horse, dog and whale bones were present, but infrequent, in all phases and a single specimen of red deer was recovered from a Viking Age deposit. Fish bones, specifically of cod, saith and ling, "of very large dimensions" were also recovered in both early and late phases. As Bigelow (1984:34) has observed, their importance was probably under-represented by the use of hand collecting for bone recovery.

The recovery of botanical material was restricted to c.15 fragments of charcoal and four preserved knife handles (Orr & Green 1956). Charcoal of willow, oak, hazel, pine, birch and possibly juniper was identified in Viking Age deposits while birch, oak and pine specimens - including the knife handles - were recovered from Late Norse phases.

The Biggings, Papa Stour

Settlement at the Biggings, dated to the 11th - 15th centuries by radiocarbon assays and imported pottery, lies several hundred meters inland on the small but fertile island of Papa Stour (Crawford 1985a;1991b;Dickson n.d.). It can be divided into three broad phases, only the second of which - an 11th - 12th century dwelling complete with a timber lined room or stofa - is considered here. Bone was not preserved at The Biggings, but botanical material was collected in a waterlogged state and disaggregated in water (no sieve size given) (Dickson n.d.). Semi-quantitative data are available for this assemblage, but are not comparable with the seed counts from other sites where preservation was by charring. The taxa represented at the Biggings are thus tabulated as presence data in Table 5.8.

Appendix 5.2

pH determinations for air dried sediment samples from Robert's Haven and Earl's Bu (using a ratio of 1 part homogenised sediment to 1 part deionized water)

Robert's Haven			Earl's Bu	
Area	Context	pH	Context	pH
Area A	3010	7.1	509	6.6
	3009	7.4	351	6.9
	3020	7.4	521	7.0
	3003	7.5	674	7.0
	2004	7.7	449	7.1
	2007	7.7	680	7.1
	1009	7.7	738	7.1
	3006	7.7	421	7.2
	1007	7.7	506	7.2
	1005	7.8	674	7.2
	3009	7.8	736	7.2
	3012	7.8	371	7.3
	2012	7.8	371	7.3
	3007	7.8	371	7.3
	3017	7.8	387	7.3
	3014	7.8	687	7.3
	2013	7.9	695	7.3
	2016	7.9	560	7.4
	1008	7.9	662	7.4
	2015	7.9	663	7.4
	3011	7.9	676	7.4
	2009	8.0	225	7.5
	3002	8.0	323	7.7
	3013	8.0		
	2002	8.0		
	2003	8.0		
	1006	8.1		
	2019	8.1		
	3015	8.1		
	1011	8.1		
	1010	8.2		
	2010	8.2		
	3019	8.2		
	2005	8.2		
	1004	8.2		
	2018	8.2		
	2017	8.3		
	2020	8.5		
	2014	8.8		
Area B	7019	7.2		
	7008	7.3		
	7020	7.4		
	7021	7.5		
	7007	7.7		
	7002	7.8		
	7002	7.8		
	7006	8.0		
	7001	8.0		
	7005	8.0		
	7009	8.1		
	7004	8.1		
	7017	8.2		
	7014	8.3		
	7003	8.3		
	7010	8.3		
	7018	8.4		
Area E	9011	7.2		
	9013	7.2		
	9003	7.2		
	5006	7.3		
	9012	7.4		
	5500	7.5		
	9014	7.5		
	5503	7.6		
	5002	7.6		
	5502	7.6		
	5501	7.6		
	5008	7.7		
	5005	7.7		
	5004	7.8		

Appendix 5.3

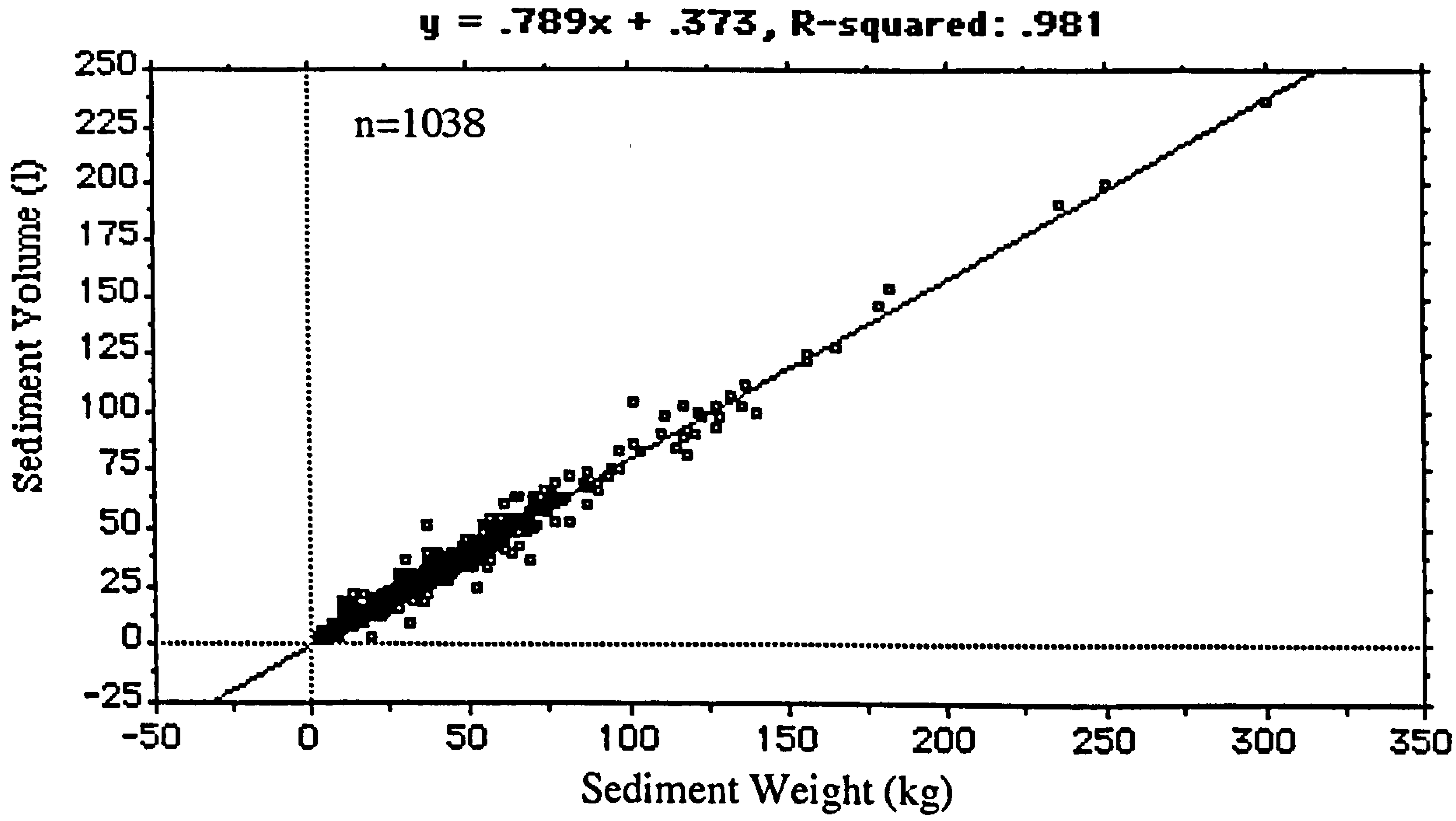
Earl's Bu phasing: The relationship between Late Norse (LN2?) contexts considered in this study and the final site sequence

		Contexts Analysed for		
Phase (Batey pers comm.)		Mammal, Fish & Bird Bone (This Study; Mainland pers comm.) Data in Tables 5.5-5.7	Fish Bone (This Study) Data in Tables 8.22-8.31	Botanical Remains (Huntley 1990) Data in Table 5.8
X	Middens - Post Mill Infill Stage III			
				35
				37
				39
		40	40	40
				41
				77
				82
				83
		115	115	
		117	117	
		118	118	
		126	126	
		145	145	
			178	
		188	188	
		190	190	
		193	193	
		194	194	
		207	207	
		236	236	
		327	327	
		332	332	
		334	334	
		336	336	
		339	339	
		356	356	
V	Middens - Post Mill Infill Stage II			
		195	195	
		196	196	
			338	
U	Clay			
				79
				90
T	Middens - Post Mill Infill Stage I			
				84
				85

Appendix 5.4

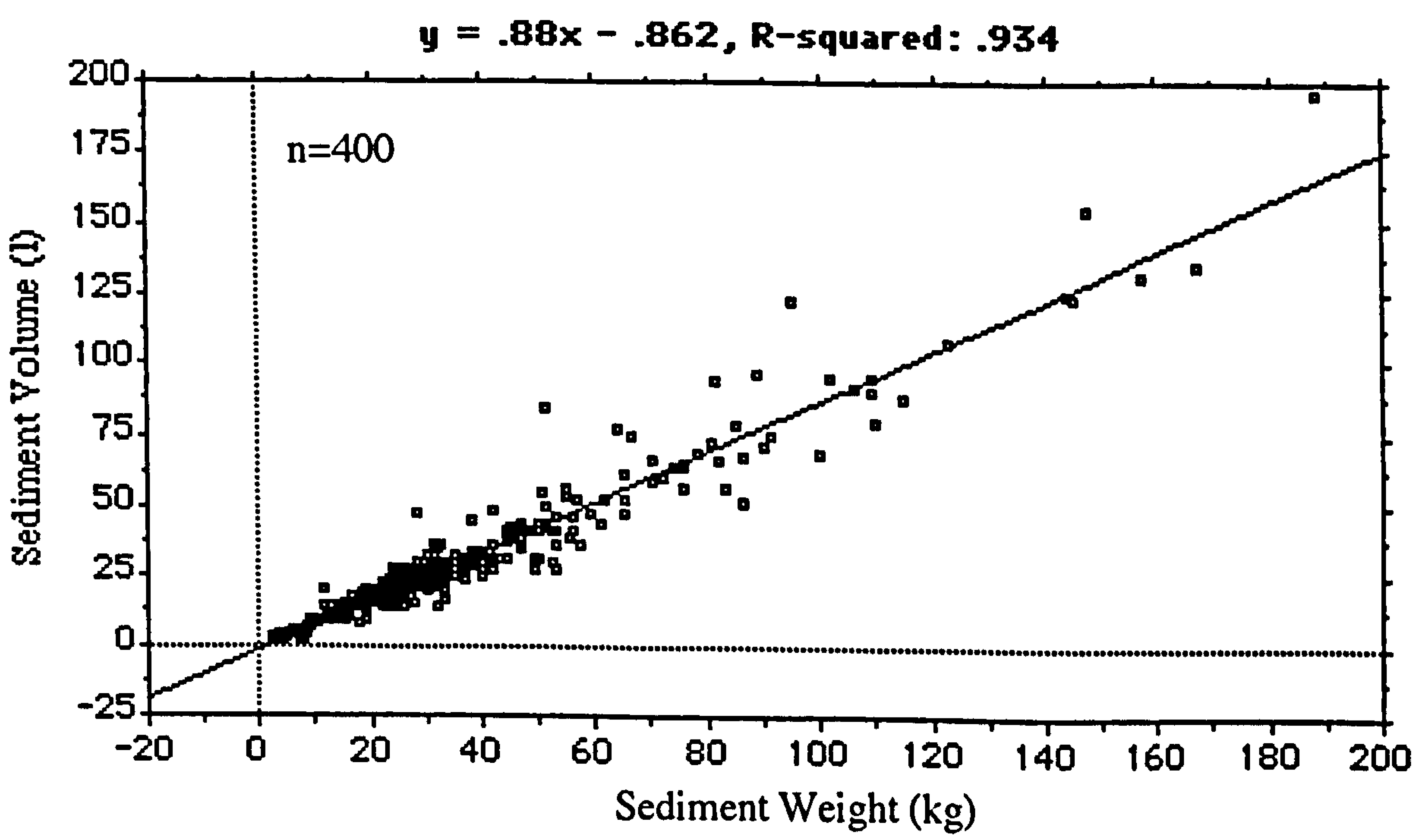
Least-squares regression equations used to predict sediment volume from sediment weight for samples with missing data from Freswick Links and Earl's Bu

Freswick Links*



*Note: Three outliers omitted

Earl's Bu*



*Note: Clay samples from Area F omitted

Appendix 5.5

Bone measurement data used to estimate total fish length for common cod family taxa in Viking Age and Late Norse Assemblages from Orkney, Caithness and Shetland (data derived from histograms for all sites except Pool, for which actual measures were available)

Site	Quoygrew All Strata		Quoygrew All Strata		Quoygrew All Strata		Tuquoy All Phases		Tuquoy All Phases	
Taxon	Cod		Saith		Ling		Cod		Saith	
Measurement	P1		D2		P1		P1		Otolith Total Length	
Reference	Colley 1983a:248		Colley 1983a:247		Colley 1983a:249		Colley 1988		Colley 1988	
	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)
	3	5.25	20	<1mm	1	8.75	2	2.75	2	2.75
	1	5.75	1	1.25	1	10.25	2	3.25	2	3.25
	2	7.25	2	2.75	1	10.75	2	4.75	8	5.25
	3	7.75	6	3.25	1	11.75	2	5.25	7	5.75
	2	8.25	7	3.75	1	12.25	2	5.75	11	6.25
	2	8.75	4	4.25	2	13.25	3	6.25	3	6.75
	4	9.25	4	4.75	2	14.75	7	6.75	9	7.25
	4	9.75	1	5.25	1	16.25	13	7.25	4	7.75
	1	10.25	2	5.75			16	7.75	3	8.25
	2	10.75	1	7.25			10	8.25	5	8.75
	1	11.75	1	8.75			17	8.75	5	9.25
	3	12.25	2	11.25			16	9.25	6	9.75
	1	12.75	1	11.75			11	9.75	1	10.75
	3	13.25	1	12.25			5	10.25	3	11.25
	6	13.75	1	13.25			8	10.75	1	13.25
	6	14.25					5	11.25	2	14.25
	7	14.75					2	11.75	1	18.25
	7	15.25					12	12.25		
	2	15.75					12	12.75		
	1	16.25					10	13.25		
	1	16.75					14	13.75		
	2	17.25					15	14.25		
							14	14.75		
							17	15.25		
							9	15.75		
							8	16.25		
							5	16.75		
							7	17.25		
							1	17.75		
							1	18.25		
							1	19.25		

Appendix 5.5 (continued)

Bone measurement data used to estimated total fish length for common cod family taxa in Viking Age and Late Norse Assemblages from Orkney, Caithness and Shetland (data derived from histograms for all sites except Pool, for which actual measures were available)

Pool	Pool	Pool	Pool	Pool	Pool
Phase 7	Phase 7	Phase 7	Phase 8	Phase 8	Phase 8
Cod	Saith	Ling	Cod	Saith	Ling
P1	P1	P1	P1	P1	- P1
Nicholson n.d. b	Nicholson n.d. b	Nicholson n.d. b	Nicholson n.d. b	Nicholson n.d. b	Nicholson n.d. b
Measure (mm)	Measure (mm)	Measure (mm)	Measure (mm)	Measure (mm)	Measure (mm)
15.9	10	14.7	15	4.3	14.9
10.4	11.4	17.3	15	11	15.3
14.8	14.2	15.2	7.4	10.7	16.9
14	13.2		15	11	17
8.7	13.5		15.7	14.3	20.4
12.2	10.1		12.7	12.4	15.6
16	9.8		17	10.3	14.6
14.7	12.7		14.6		15.8
13.3	11		15.9		
15.1	11.6		4.6		
9.8	14.7		14.8		
15.8	15.1		12.5		
16.9	11.3		16		
13.3	11		12.3		
15.1			9.3		
11.7			14.6		
15.7			13.3		
13.2			14.7		
11.2			12		
13.9			8.5		
12.6			17		
10.7			17.5		
13.8			14.7		
15.4			15.6		
16.6			12.3		
12			12.7		
14.8			14.2		
14.5			13.1		
14.5			8.5		
15.3			18.6		
8.3			13.8		
10.3			12.8		
			15.9		
			13.1		
			14		
			14		
			17.2		
			15.2		
			14.5		
			18.5		
			11.6		
			8.4		
			10.1		
			14.8		
			16.5		
			12.3		
			15.8		
			16.9		
			14.4		
			17.8		
			14.7		
			16.8		
			8.2		

Appendix 5.5 (continued)

Bone measurement data used to estimated total fish length for common cod family taxa
in Viking Age and Late Norse Assemblages from Orkney, Caithness and Shetland
(data derived from histograms for all sites except Pool, for which actual measures were available)

Beachview All Phases (Sieved & Unsieved) Cod P1 Rackham et al. forthcoming d		Beachview All Phases (Sieved & Unsieved) Saith P1 Rackham et al. forthcoming d		Freswick All Strata Cod P1 Jones 1991a:212		Freswick All Strata Saith P1 Jones 1991a:205	
Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)
2	7.25	7	1.75	2	4	4	2
1	7.75	7	2.25	3	5	5	3
2	8.75	2	2.75	8	6	6	4
2	9.25	1	3.25	12	7	12	5
1	9.75	2	4.75	15	8	2	6
2	10.25	1	5.25	13	9	5	7
3	11.25	1	6.25	27	10	2	8
7	11.75	1	7.75	41	11	3	10
4	12.25	1	8.25	39	12	2	11
7	12.75	2	8.75	32	13	7	12
14	13.25	1	9.25	27	14	2	14
13	13.75	1	9.75	21	15	1	15
8	14.25	1	10.75	23	16		
14	14.75	1	13.1	10	17		
9	15.25			2	18		
6	15.75			1	19		
4	16.25			1	20		
2	16.75						
1	17.7						

Bone measurement data used to estimated total fish length for common cod family taxa in Viking Age and Late Norse Assemblages from Orkney, Caithness and Shetland (data derived from histograms for all sites except Pool, for which actual measures were available)

Freswick All Strata Ling P1 Jones 1991a:222		Freswick All Strata Haddock P1 Jones 1991a:216		Sandwick MU2, MU 3 & 4 Middle-Late Cod P1 Bigelow 1984:277		Sandwick MU2, MU 3 & 4 Middle-Late Saith Total Otolith Length Bigelow 1984:276		Sandwick All Phases Ling P1 Bigelow 1984:278	
Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)	Count	Measure (mm)
1	3	9	4	7	7.5	3	6.5	1	6.5
1	7	5	5	4	8.5	7	7.5	3	7.5
2	8	2	6	3	9.5	44	8.5	3	10.5
3	9			2	10.5	54	9.5	6	11.5
6	10			4	11.5	9	10.5	10	12.5
6	11			9	12.5	12	11.5	8	13.5
11	12			11	13.5	5	12.5	8	14.5
20	13			20	14.5	1	13.5	3	15.5
17	14			11	15.5	1	16.5	1	16.5
14	15			5	16.5	3	17.5		
6	16			1	17.5	4	18.5		
1	17			1	18.5	3	19.5		
				1	10.5	10	20.5		
				1	5.5	2	21.5		
				1	6.5	1	22.5		

Appendix 5.6

Fish bone measurement data from Robert's Haven and Earl's Bu

Robert's Haven

Cod Measure D1	Cod Measure D2	Cod Measure D1	Cod Measure D2
4.6	3.8	3.5	3.8
4.7	5.6	3.4	3.6
5.4	4.3	3.5	3.8
5.4	5.3	4.0	3.5
4.6	4.9	3.7	4.4
5.0	5.6	7.5	3.4
5.4	4.6	10.2	7.2
5.4	5.2	9.0	9.8
6.0	4.7	9.4	9.5
6.0	5.9	9.0	9.3
5.4	5.5	8.4	9.9
5.7	4.0	9.3	9.3
3.9	6.7	9.4	10.3
4.3	6.0	10.1	10.0
5.5	4.1	9.3	10.8
6.5	4.8	8.7	10.2
5.6	5.4	8.3	7.5
4.3	5.0	10.1	6.9
5.3	4.6	8.2	4.8
5.0	7.0	10.3	4.5
5.4	4.4	9.8	5.7
5.5	5.1	9.0	3.9
4.3	5.4	8.9	3.6
6.9	6.1	9.0	4.1
6.5	6.4	9.7	8.1
5.6	4.7	10.9	8.1
4.4	4.8	8.9	9.0
4.5	5.3	7.7	7.9
5.1	4.9	8.1	
4.8	6.0	8.9	
4.4	5.3	9.8	
5.7	6.2	3.7	
5.5	6.0	7.7	
5.4	5.6	6.1	
5.8	5.6	6.7	
6.4	4.3	4.2	
3.8	5.4	8.9	
5.0	4.1	7.5	
4.0	6.0	10.4	
5.3	6.3		
6.0	3.8		
2.8	3.0		
3.7	3.6		
3.4	3.1		
3.5	3.7		
3.5	4.0		
3.7	3.7		
3.5	3.5		
4.0	4.1		
3.8	4.0		
3.6	4.4		
2.8	3.9		
3.5	3.7		
3.8	2.9		
3.1	3.2		
3.4	3.7		
3.9	3.8		

Haddock Measure D1	Haddock Measure D2
2.2	2.5
	6.0

Ling Measure D1	Ling Measure D2
5.9	5.3
6.0	1.4
1.6	1.3
1.6	8.7
9.3	9.0
15.4	12.4
11.2	11.2
10.2	13.9
11.8	12.2
13.1	

Pollack Measure D1	Pollack Measure D2
6.3	6.5
7.9	9.2
3.3	9.9
10.5	9.1
8.8	5.0
12.3	3.2
5.4	10.7
	4.9

Saith Measure D1	Saith Measure D2
4.7	4.9
5.0	5.1
7.6	6.1
6.5	7.6
6.8	5.5
5.5	6.5
6.8	4.9
5.5	5.7
5.3	5.4
4.8	5.6
4.6	4.6
5.0	5.6
5.0	5.3
6.8	4.8
5.8	3.3
5.3	3.8
4.8	4.5
4.2	3.7
5.1	3.8
3.1	4.0
4.0	4.1
4.2	4.0
3.5	4.6
3.7	4.2
3.5	3.8
4.3	3.1
4.2	3.6
4.0	4.4
4.3	3.7
4.5	3.5
3.9	3.3
4.5	4.1
4.3	3.9
3.1	3.8
2.7	4.5
2.7	3.8
4.5	3.9
4.1	4.3
3.2	1.7
3.6	2.9
3.0	2.7
3.5	1.8
4.0	1.6
4.5	1.5
3.8	9.1
3.8	11.8

Saith Measure D1	Saith Measure D2
4.2	12.8
2.5	12.8
1.8	12.2
2.8	11.9
2.7	13.1
1.7	12.3
2.2	12.2
2.6	10.5
2.7	11.9
1.8	12.8
1.7	11.1
9.3	11.5
11.1	10.3
11.0	9.6
11.5	12.3
11.5	12.2
10.5	12.4
9.3	11.2
10.0	13.7
9.2	8.9
10.0	10.0
10.4	14.5
10.8	14.2
10.5	13.0
10.0	13.2
10.5	3.1
11.8	3.8
11.6	3.9
11.0	2.0
10.0	2.1
10.5	2.7
9.1	2.6
8.0	1.1
11.5	
10.8	
10.9	
11.1	
9.7	
12.6	
10.9	
10.3	
11.8	
11.9	
11.4	
10.0	
2.7	
3.9	
2.2	
2.6	
2.5	
1.1	
1.5	

Torsk Measure P1	Torsk Measure P2
5.8	5.4

Fish bone measurement data from Robert's Haven and Earl's Bu

Robert's Haven

Cod Measure P1	Cod Measure P2	Cod Measure P1	Cod Measure P2	Pollack Measure P1	Pollack Measure P2	Saith Measure P1	Saith Measure P2	Ling Measure P1	Ling Measure P2
10.3	6.7	4.2	8.0	8.9	4.5	5.4	2.5	5.3	4.3
7.4	4.7	5.8	10.2	7.8	3.7	4.1	2.6	4.5	3.8
6.8	5.0	2.8	11.3	9.8	3.2	4.4	2.6	5.8	4.1
7.0	6.5	3.5	11.1	7.1	4.3	5.4	2.3	4.4	3.3
9.5	5.3	11.7	8.9	9.0	10.2	5.5	2.7	6.5	5.1
7.3	5.0	10.1	9.5	14.6	3.4	9.7	1.8	11.1	9.3
7.7	7.1	14.4	10.9	6.5	2.4	4.9	2.3	10.6	7.8
7.1	7.3	11.0	10.2	7.8	1.8	3.4	1.7	11.7	10.1
10.6	5.9	15.3	8.6	4.8		4.2	1.7	11.6	10.1
10.4	5.9	13.8	7.8	3.3		2.9	1.3	13.4	7.3
9.9	4.6	14.9	10.4			3.0	1.5	7.0	5.8
8.5	5.6	12.0	9.2	Saith Measure	Saith Measure	2.1	1.6	12.8	10.8
9.1	7.8	12.4	7.3	P1	P2	2.3	1.6	12.7	10.4
7.4	5.0	14.1	8.5	5.5	3.0	2.6	1.8	12.8	8.9
8.3	5.4	13.6	8.7	5.7	2.9	2.8	1.6	13.1	10.7
11.7	4.5	13.1	8.3	6.4	3.0	3.1	1.7	13.4	10.5
10.8	4.8	11.3	9.8	5.7	3.0	3.2	1.8	13.0	4.1
7.3	6.4	12.5	9.3	6.0	4.0	2.9	1.7	10.7	11.0
7.8	4.6	13.8	9.5	8.7	3.1	3.0	1.5	11.9	10.6
7.3	4.5	11.9	9.0	5.6	4.4	2.8	5.6	11.5	10.3
8.3	5.6	12.7	9.5	7.8	3.0	1.8	5.3	11.5	10.2
9.9	5.5	13.1	7.9	6.1	3.3	10.3	5.9	10.9	8.2
8.2	4.5	14.7	9.4	7.5	3.1	11.8	5.3	11.3	8.4
6.8	4.3	12.0	9.2	5.7	4.5	11.8	5.4	12.8	10.0
8.2	7.0	14.3	10.3	8.5	4.3	9.3	4.4	10.8	11.4
8.2	5.8	11.7	10.4	8.1	3.3	11.0	4.8	12.3	10.0
8.3	4.5	13.0	10.1	6.0	2.7	10.4	4.5	17.2	10.3
7.2	4.1	11.9	9.9	5.7	2.8	11.5	4.5	12.0	14.5
6.9	4.0	13.3	11.8	5.8	4.0	10.9	4.5	10.8	9.8
9.9	4.0	11.6	8.6	8.4	2.8	9.3	5.2	12.4	8.8
8.7	4.3	12.2	10.8	6.0	3.2	12.1	6.8	13.7	9.7
6.3	4.0	10.3	10.8	5.8	3.3	11.9	5.8		9.9
6.2	4.3	14.6	4.2	5.6	4.1	12.5	6.7		8.6
5.8	3.2	11.6	4.6	7.9	2.1	12.4	6.8		
5.9	3.9	14.7	5.6	3.8	1.7	13.2	5.9	Haddock Measure	Haddock Measure
6.1	4.3	18.0	3.5	3.5	2.3	12.6	6.0	P1	P2
6.4	4.9	16.0	4.1	4.6	2.2	12.1	4.9	3.9	2.9
5.8	4.0	17.5	4.4	5.0	2.6	12.6	6.9	3.3	
5.7	4.7	13.6	3.8	4.3	2.1	12.0	5.5		
6.1	3.2	16.1	1.6	3.5	1.8	12.0	6.0		
5.0	4.5	17.6	1.3	4.6	2.5	12.4	5.5		
6.4	3.3	6.8	0.8	4.0	2.1	9.2	3.8		
6.5	4.2	6.8	9.8	5.0	2.5	3.3	2.5		
7.2	3.9	6.2	7.6	4.2	2.5	2.5	2.5		
6.2	4.2	6.1	9.4	5.4	2.1	3.4	1.7		
11.5	4.2	6.5	7.9	3.8	2.5	2.7	1.7		
5.1	3.9	5.5	9.0	6.1	2.1	3.3	1.4		
6.0	4.6	2.7	9.9	4.5	3.3	2.8	1.9		
5.7	3.4	2.0	4.3	4.6	1.8	3.1	1.1		
6.8	3.9	1.5		4.3	3.1	1.8	7.8		
6.3	2.7	12.3		3.4	2.4	13.4	4.9		
6.5	4.3	15.3		5.3	2.2				
6.8	1.7	13.4		4.0	2.7				
5.6	2.2	11.2		4.1	2.4				
6.2	7.8	13.0		5.4	2.4				
5.0	8.7	15.8		4.2	2.6				
5.5	8.8	11.3		4.0	2.4				

Fish bone measurement data from Robert's Haven and Earl's Bu

Earl's Bu

Cod
Measure D1
3.3
6.9
5.8
5.2
4.1
4.6
4.3
4.4
5.0
4.2
4.1
4.3
7.2
6.8
4.5
6.0
9.1
8.2
3.9
4.3
4.5
5.7
8.6
5.2
5.6

Cod
Measure D2
5.8
3.8
5.4
4.6
4.9
4.5
4.5
5.6
8.3
6.0
7.9
4.5
5.9
5.9
4.8
5.1
10.0
8.6
5.8
5.5

Saith
Measure D1
11.0
10.0
11.0
2.5
1.7

Saith
Measure D2
12.0
12.0
13.0
2.8
1.7
4.8

Haddock
Measure D1
3.0
3.0
3.6
3.7
3.2
3.5
3.3
2.9
3.9
3.1
4.0
3.2
3.0

Haddock
Measure D2
3.3
3.5
4.0
3.2
3.8
3.0
3.3
5.9
6.1
3.2

Cod
Measure P1
15.0
5.8
14.0
6.5
6.2
6.7
5.8
17.0
6.4
7.1
16.0
5.6
5.0
6.9
5.5
8.2
5.2
8.8
8.9
12.0
14.0
5.0
6.4
7.2
8.3
6.9
7.1
8.0
5.8
9.3
7.5
5.0
7.1
9.6
15.0
10.0
15.0
8.8
12.0
8.1
7.1
7.9
8.3
9.5
14.0
9.6
10.0
12.0
13.0
7.2
5.6
7.4

Cod
Measure P1
6.2
8.3
4.6
16.0
8.5
15.4
7.0
8.1
9.3
9.5
6.0
6.7
5.8
13.0
13.9
3.4

Cod
Measure P2
4.0
9.9
4.2
12.0
4.9
9.9
4.7
4.3
6.8
6.9
11.0
4.4
5.8
5.5
5.2
5.6
6.2
8.7
6.5
10.0
5.0
5.6
12.0
5.3
10.0
11.0

Saith
Measure P1
12.0
11.0
10.0
12.0
12.0
5.4
2.1

Saith
Measure P2
5.0

Ling
Measure P1
8.4
7.9
13.1

Ling
Measure P2
7.1
11.3
3.0
3.8

Haddock
Measure P1
5.6
3.9
4.7
4.5
5.3
5.8
4.3
5.1
4.8
5.1
5.4
4.5

Haddock
Measure P2
3.2
3.9
4.4
3.2
4.3
3.6
4.0
4.1

Appendix 5.7

Aging Evidence for Cattle and Sheep from Viking Age and Late Norse Assemblages

Aging data regarding faunal assemblages of Norse date from Orkney, Caithness and Shetland have not been consistently published to a standard which would facilitate meaningful tabular representation. It is thus necessary to summarise the available evidence in narrative form. Where methods are explicit, age at death profiles for cattle and sheep were determined using dental eruption sequences, tooth wear and (particularly) epiphysial fusion sequences (Bigelow 1984:134; Bond forthcoming; McCormick forthcoming; Noddle 1976-1977:201; forthcoming; Rackham 1989:244-246; Rackham et al. forthcoming d; Gidney forthcoming; Rowley-Conwy 1983:109; Seller 1982:135). The standards used, such as those published by Silver (1969) for epiphysial fusion, are not without problems (Payne 1972:76; see also Moran & O'Connor 1994). However, they may provide gross sequential patterns regardless of the precise correlation between fusion, eruption or wear stages and true calendar age.

Most of the available Viking Age faunal assemblages are small. Nevertheless, collections from Buckquoy, Saevar Howe, Brough Road Areas 1 and 2, the Brough of Birsay Room 5, Skaill Deerness and Pool provide useful information (Bond forthcoming; Noddle 1976-1977; forthcoming; Rackham 1989; Rowley-Conwy 1983; Seller 1982). Data from phase 2 of Sites VII-IX on the Brough of Birsay can be used in a supplementary way, but Seller's (1986) report lacks sufficient methodological discussion to facilitate confident comparative use of his age determinations.

The Viking Age faunal assemblage from Saevar Howe included 79 fragments identified as *Bos* (Rowley-Conwy 1983:MF75). Given this tiny sample, quantitative discussion of aging evidence is meaningless. It is relevant to note, however, that Rowley-Conwy (1983:110; MF85) interpreted the presence of bones from calves no more than a few weeks old as possible evidence for dairying. The sheep assemblage from Saevar Howe was similarly small (116), but most of the bones which could be aged were from immature animals. Rowley-Conwy interpreted this pattern as evidence for meat production, but also raised the possibility that sheep were used for milk and wool. Some mature and very young animals were represented in the assemblage (Rowley-Conwy 1983:110-111, MF84).

The Buckquoy assemblage is more substantial, with 1396 fragments identified as cattle and 868 as sheep (Noddle 1976-1977:Table 1). Cattle were more often killed as calves (perhaps less than 1 year) or older adults (perhaps greater than 4 years) than as animals of intermediate age (perhaps 1 to 4 years) (Noddle 1976-1977:205, Table 6).

Conversely, the sheep data are more evenly distributed among the same three age categories (Noddle 1976-1977:205, Table 6). Noddle's interpretation of these data is somewhat idiosyncratic. She argued that there is "little evidence of any economic function for the animals other than the provision of meat and hides" (Noddle 1977:205). Following Legge's (1981:86; see above) criteria, the cattle age distribution could be interpreted as a dairying strategy. As Rackham et al. (forthcoming d) suggest, however, a multipurpose herd is the most reasonable interpretation for both cattle and sheep. Juvenile, immature and mature animals are all well represented.

Rackham (1989:246-247, Table 26) considered the aging evidence from Brough Road Areas 1 and 2 insufficient to reconstruct slaughter patterns. He notes, however, the presence of both juvenile and adult cattle. The sheep assemblage is similarly problematic, but there is little evidence of very young and very old individuals.

The Norse phases from Room 5 on the Brough of Birsay produced 673 specimens identified as cattle and 967 identified as Sheep (Seller 1982:133). The aging evidence is modest, but does suggest that both cattle and sheep died between less than 1.5 years and greater than 3.5 years of age (Seller 1982:Table 6). Little more can be said about the cattle data as they vary considerably from phase to phase. The sheep data cluster at the upper end of this range (Seller 1982:Table 6), but bone preservation was very poor on the Brough (Colley 1989:258) and there is no explicit discussion of the degree to which sieving was employed (Seller 1982). Lamb bones may thus be under-represented. Although Seller (1982:132) interpreted the Room 5 data as evidence for wool and milk production, it is difficult to be confident in this suggestion.

Seller (1986:209, 211, 213-215) draws similar conclusions regarding the Phase 2 assemblage from Sites VII-IX on the Brough of Birsay. This is among the larger Viking Age collections with 1374 cattle and 1071 sheep specimens (Seller 1986:208, Table 10). It is also subject, however, to the preservation and recovery problems just discussed in the context of Room 5. Both cattle and sheep exhibited possible ages ranging from less than 1.5 to greater than 3 years. Older animals were noticeably more common in both taxa (Seller 1986:Tables 16, 17, 23, 24, 30, 31).

The aging evidence from Norse phases at Skaill, Deerness, do suggest that almost half of the cattle died as neonates (based on analysis of 2751 specimens) (Noddle forthcoming). Nevertheless, more individuals died as juvenile or immature animals, presumably butchered for meat, than were killed as mature animals kept for the production of milk. The sheep data (2263 specimens) are even less consistent with Legge's model. The proportion of animals which died in each of Noddle's (forthcoming) four age classes is relatively even.

Pool may provide some positive support for the existence of a dairying economy in the Viking Age and Late Norse earldoms. Neonatal calves, some with butchery marks, were particularly abundant in both phase 7 (VA1) and phase 8 (VA2-LN1) (Bond forthcoming). However, this pattern began in the Pictish period, not at the Viking Age/Late Norse transition. Moreover, few mature animals were represented and 20-25% of the animals died between Bond's (forthcoming) epiphysial fusion stages 1 and 4 (c.18 months to 3.5-4 years). These two factors are perhaps more consistent with a mixed economy, or even one based on meat production, than intensive dairying. Bond suggests that old animals were removed from the site prior to butchery, but it may also be conceivable that few reached maturity. The sheep bone from Pool illustrates a different picture, with fewer neonatal specimens and the majority of animals living to their second or third years of life (Bond forthcoming). These animals were presumably sought for their meat and one or two clips of wool (Bond forthcoming).

Three Late Norse assemblages (in addition to Pool Phase 8, just discussed in the context of Pool Phase 7) have yielded notable aging data: Sandwick, the Beachview Studio Site and Freswick Links. In his preliminary analysis of faunal material from Sandwick, Shetland, Gerald Bigelow (1984:133-134; see also 1989:188; 1992:19) suggested that cattle bones were characterised by very young (most possible less than six months and some possibly less than 5-9 weeks) and fully adult individuals. He interpreted this pattern as evidence for an intensification in dairying activity during the transition from the Viking Age to the Late Norse Period (Bigelow 1984:133-134, 228-229, 283; 1987:32-34; 1989:188; 1992:19).

While Bigelow's model has been influential (e.g. Amorosi 1989a:219; McGovern et al 1988:261; Rackham et al. forthcoming d), it is based on relatively modest data. The preliminary faunal analysis on which his age estimates were based included 693 identified cattle bones (Bigelow 1984:Tables 11-13). Although he mentions "*numerous* mandibles and maxillae with unworn, or only lightly worn deciduous dentition and unerupted first molars" and "*many* unfused atlas vertebrae" the aging evidence cannot have been extensive given the small total number of cattle bones (Bigelow 1984:134 emphasis mine).

Little evidence is currently available regarding the sheep bones from Sandwick. Bigelow does suggest, however, that the latter derive predominately from fully mature individuals. Recovery bias is unlikely given the use of 1.5mm and 3mm sieves (Bigelow 1984:114). Although Bigelow (1984:133, 220-221) downplays the importance of sheep - given their numerical decline in the second phase of Sandwick's occupation - it is possible that this age profile reflects some attention to milk (or wool) production in Late Norse Shetland.

The epiphysial fusion data for cattle from Beachview suggests a relatively distinct pattern of slaughter (Rackham et al. forthcoming d). Animals were killed, or died naturally, as calves (from birth to perhaps 6-10 months), after fusion of the distal tibia and distal metacarpus but before fusion of the distal metatarsus and proximal calcaneus (perhaps 2.5 years) and after skeletal maturity (perhaps greater than 7 years) (Rackham et al. forthcoming d). Rackham et al. suggest a variety of explanations for this pattern, including the removal of calves from milking cows. In conclusion, however, they argue that substantial calf mortality is a natural phenomenon and that the slaughter of an intermediate age group is best interpreted as evidence for a multi-purpose herd. Although not inconsistent with intensive milk production, the Beachview data do not substantially contribute to such an argument.

Rackham et al. interpret the sheep bones from Beachview in a similar vein. Epiphysial fusion data again suggest three peaks in mortality - one of first year animals (over 25%), one of animals with unfused distal metapodials and tibiae (perhaps prior to 18-24 months, 45%) and one of skeletally mature individuals (perhaps greater than 5 years, 25%) (Rackham et al. forthcoming d). While the high mortality of first year individuals may be natural, Rackham et al. suggest that the second year animals probably represent an emphasis on meat rather than wool (or milk) production. They contrasts this evidence with the pattern of a typical wool flock in which older individuals are slaughtered. The relatively low proportion of skeletally mature individuals would therefore represent breeding ewes which also provided some wool and milk.

The aging evidence from Freswick Links varies from area to area. The modest assemblage from the Northern Cliff Areas (NCA) is dominated by bones of neonatal and juvenile cattle (Gidney forthcoming). The Middle Cliff Areas (MCA) also had a substantial number of young specimens (Gidney forthcoming). However, adult fused epiphyses were more common than in NCA and some of the juvenile specimens derived from articulated carcasses (inflating the contribution of this age group). The Southern Cliff Areas (SCA), predominately Pictish in date, yielded a more even distribution of fused and unfused epiphyses (Gidney forthcoming). Aging data from Areas 3 and 9 are best left unconsidered. The former is poorly dated and the latter yielded only a tiny mammal assemblage. Similarly, sheep were too poorly represented throughout the site to substantiate interpretations regarding age at death profiles.

With some trepidation, Seller's data from Phase 3 of Sites VII-IX on the Brough of Birsay can be appended to these results. Cattle may have died at ages ranging from less than 1.5 years to greater than 3.5 years. However, the evidence clusters at the upper end of this range, suggesting that some animals had been kept for resources such as milk (Seller 1986:215, Tables 16-17, 23-24, 31). Sheep died at ages from less than one year to greater than three years, but demonstrated a general trend towards survival beyond three years (Seller 1986:Tables 16-17, 23-24, 31). Seller interpreted this pattern as evidence for wool and perhaps milk production (1986:209, 212, 215). Once again, however, lamb bones may be under-represented given the poor preservation of bone and uncertainties regarding recovery on the Brough.

The predominance of older cattle and sheep in several collections from the Brough of Birsay deserves some comment. This pattern may suggest an emphasis on secondary products, but the Brough is a specialised settlement of high status which may not have engaged in local farming. These assemblages are probably not particularly useful for the reconstruction of herd management strategies of general relevance to the earldoms.

Appendix 7.1

Robert's Haven sample data (based on sorting to 4mm)

Column	Context (stratigraphic order)	Sample (stratigraphic order)	Phase	Soil Volume (l)	Soil Weight (kg)	Shell (g)	Fish Bone (g)	Mammal Bone (g)	Bird Bone (g)	Carbonised Vegetation (g)
AREA A										
A	1002	1001	1	1	3.4	5.3	6			0.1
A	1003	1002	1	10.5	11	48.5	71.1	5.2	0.1	1.7
A	1004	1003	1	14	14.2	43.8	223.5	6.1	0.1	20.3
A	1005	1005	1	7	7.6	53.8	390.1	2.2		42.7
A	1005	1006	1	7	8.2	93.3	667	2.8	2.4	44.4
A	1006	1007	1	21	21.4	767.9	697.9	7.5	6.6	30.6
A	1006	1008	1	14	13.6	552.9	311	10.9	2.2	19.2
A	1007	1009	1	35	32	364.9	632.8	10.6	1.8	57.6
A	1008	1010	1	38.5	36	310	685.1	28.6	1.1	129.6
A	1009	1011	1	17.5	16.6	91.4	455.5	1.6	0.6	55.6
A	1011	1013	1	38.5	40.3	495.6	803.3	20.7	2	53.9
A	1010/1012	1012/1014	1	31.5	36.2	813.9	331.6	7	1.5	23.3
A	1013	1015	1	21	26.4	301.9	256.2	2	0.6	8.2
A	1013	1016	1	24.5	31.2	630.9	281.2	11.4	0.5	12.2
A	1013	1017	1	24.5	33.8	786.3	168.9	16.6	0.8	6
B	2015	2015	1	7	7	168	26.9	0.1	1	2.7
B	2016	2016	1	14	15.4	338.8	153	0.7	0.1	10.9
B	2017	2017	1	10.5	11.2	69.1	47.4	2.7		18.5
B	2017	2018	1	14	13	32.8	229.8			12.6
B	2017	2019	1	3.5	7.4	33.8	107.8		5.5	0.9
B	2018	2020	1	14	17.4	97.2	20.7		0.4	2.5
B	2018	2021	1	24.5	26.4	561.9	538.5	1	7.2	11
B	2019	2022	1	3.5	6	5.3	18.1			2.2
B	2003	2023	1	17.5	23.8	399.7	345	1	0.3	16.3
B	2020	2024	1	10.5	11.4	50.5	0.7	0.2		
B	2005	2025	1	10.5	12.3	79.2	2.4	3		0.1
B	2002	2001	1	7	9.2	52.1	4.1	1.2	0.7	1.9
B	2002	2002.1	1	7	9.2	43.2	11.5	0.8		1.5
B	2004	2002.2	1	10.5	11.2	82.4	69.4	1.9	0.1	5.1
B	2004	2003	1	7	9.5	73.1	60.1	10.3	0.3	1.9
B	2007	2005	1	7	8.6	41.4	34.9	0.4	0.1	1.9
B	2006	2004	1	3.5	6.2	38.7	12.7	0.8	0.1	
B	2009	2006	1	10.5	10	51.5	107.7		1.4	6.4
B	2009	2007	1	21	25.6	175.6	218.9	21.4		8.5
B	2010	2008	1	14	16.2	202.5	301.8	1.6	0.6	1.8
B	2010	2009	1	3	3.5	42.2	65.3	0.5		1.5
B	2011	2010	1	10.5	10.8	136.6	250			1
B	2012	2011	1	14	13	158.1	230	12.3	0.1	4.1
B	2012	2012	1	17.5	20.6	454.9	358.2	6.7	0.2	13.4
B	2013	2013	1	14	15.2	271	109.7	3		3.5
C	3002	3001	1	26	32	70.8	1.5	0.1		0.6
C	3003	3002	1	28	33	540.6	67.9	4.7	0.2	7.3
C	3003	3003	1	1	2	20.3	1.2			0.2
C	3003	3004	1	8	9	150.9	26	0.2		5.7
C	3004	3005	1	12	11	245	84.6	0.2	3.8	7.6
C	3005	3006	1	6	7	109.8	31.8	1.4	0.2	3.1
C	3006	3007	1	32	33	594.5	177.8	5.3	1.5	17.2
C	3007	3008	1	16	21	264	13.3	0.2		1.2
C	3009	3009	1	14	15	146.3	38.2	1.8	0.7	3.4
C	3009	3010	1	2	6	74.6	15.9	0.4	0.1	1.1
C	3010	3011	1	20	23	521.3	256.1	7.8	0.1	7.6
C	3016	3012	1	1	2	3.5	2.7	0.1	0.2	0.2
C	3017	3013	1	15	15	225	200.2	7	0.5	8
C	3011	3014	1	12	13	448.9	244.3	2.8	0.2	13.2
C	3012	3015	1	16	18	155.8	203	0.3	7.7	9.5
C	3013	3016	1	20	25	315.7	503.3	2.7	trace	10.7
C	3014	3017	1	16	24	275.7	269.2	8.3	trace	9.9
C	3015	3018	1	45	59	1041.3	282.3	14	1.4	13.8
C	3018	3019	1	6	8	118	17.9	3.8		1.1
C	3019	3020	1	26	36	876	172.3	16.8	0.4	5.8
C	3020	3021	1	12	15	122.7	0.4			0.1

Robert's Haven sample data (based on sorting to 4mm)

Column	Context (stratigraphic order)	Sample (stratigraphic order)	Phase	Soil Volume (l)	Soil Weight (kg)	Shell (g)	Fish Bone (g)	Mammal Bone (g)	Bird Bone (g)	Carbonised Vegetation (g)
AREA B										
G	7002	7001	4	0.5	2	3.8	0.2			0.3
G	7003	7002	4	2	5	8.8	0.3			0.2
G	7004	7003	4	14	14	62.5	0.2	0.3	0.2	1.7
G	7004	7004	4	6	7	19.6	0.2	0.4		0.8
G	7005	7005	3	8	8	29.3	1	1.4		1.2
G	7005	7006	3	2	4	16.3	0.4			0.2
G	7006	7007	3	4	4	25.6	1.6			0.9
G	7007	7008	3	34	31	222	9.4	1.6	1.5	37
G	7007	7010	3	49	49	311.6	22	10.4	1.7	27.1
G	7007	7011	3	8	9	48	2.3	0.4	0.3	6.6
G	7009	7012	3	2	4	13.4	0.1			0.01
G	7011	7015	3	2	3	14.8				0.1
G	7010	7013	3	6	7	23.7	0.5	0.1		0.7
G	7010	7014	3	4	9	33.1	0.3			2
G	7015	7017	3	14	19	2.2				
G	7014	7018	2	7	9	391.4	4.5	0.4		5
G	7016	7016	2	76	102	124.5	0.4	0.1		3.1
G	7017	7019	2	1	2	765	5.3	3.8	0.1	5.2
G	7018	7020	2	23	26	665.7	2.5	1.8	0.4	0.9
G	7019	7021	2	38	44	10933	36.7	35.9	4	29.3
G	7019	7022	2	46	50	307.7	4.2	4.5		4
G	7020	7023	2	42	64	3820.5	7.9	11.1	0.7	6.7
G	7020	7024	2	58	78	7236.6	8.9	3.3	0.4	4.5
G	7020	7025	2	17	27	1250	7.7	14.2		6.8
G	7021	7026	1	36	56	716.7	29	30.3	6.8	21.4
G	7022	7027	1	34	49	920.7	31.7	6.7	2	5.1
H	8001	8001	4	6	8	68.6	1.1	7		1.7
H	8002	8002	4	26	26	342.9	3.1	4.2	1	8.8
H	8003	8003	4	5	5	78.3	0.1	0.1		1.1
H	8004	8004	3	63	67	580	16.7	13.6	0.6	105.1
H	8004	8007	3	9	10	67	1.9	0.7	0.1	9.4
H	8005	8005	2	8	10	117.7	0.5		0.1	2.9
H	8006	8006	2	5	6	28.9	0.6	5.7		1.8
H	8007	8008	2	32	41	579.2	0.8	0.1		5
H	8008	8009	2	7	10.5	199.1	1.7			4.9
H	8009	8010	2	46	62.4	3062.3	12.1	1	0.2	1.9
H	8010	8011	2	44	59	1575.9	7.1	9.9	0.1	3.4
H	8011	8012	2	15	19	1515.1	0.5	0.8	0.5	1.6
H	8012	8013	2	40	50	5295.2	15.8	5.6	0.3	1.1
H	8013	8014	2	52	58.5	12971	0.3	48.5	0.1	trace
H	8013	8015	2	21	26	4259	2.5	1	0.1	0.3
H	8014	8016	1	11	17	1120	2.8	8.4	2.1	1.7
H	8014	8017	1	8	15	354.5	4.1	0.5		1.1
AREA E										
E	5001	5001	4b	57.5	58	505.3	10.3	14.9	3.2	7.8
E	5002	5002	1	54	54	238.9	3.9	4.7	0.5	7.75
E	5002	5003	1	145.5	176.7	1005.9	21.8	49.2	8.8	21
E	5004	5005	1	116	104.8	421.7	22.8	59.5	5.3	22.7
E	5004	5006	1	67.5	89.4	149.9	13	32	2.7	8
E	5004	5007	1	180	204.4	581.1	35.1	74.8	8.4	23.6
E	5005	5008	1	78	83	668.4	11.7	25.2	1.7	22.5
E	5005	5009	1	46	50.5	2576	46.5	155.3	5.9	61
E	5005	5010	1	85	86.8	1676.3	51.9	40.1	3	65.5
E	5007	5012	1	14	15.1	7.2	0.2			0.3
E	5008/5500	5500	1	58	60	19	0.6	0.9		0.3
E	5501	5501	0	26	33	0.6		0.2		
E	5503	5502	0	54	68	1.8		0.1		
E	5502	5503	0	14	19					

Appendix 7.2

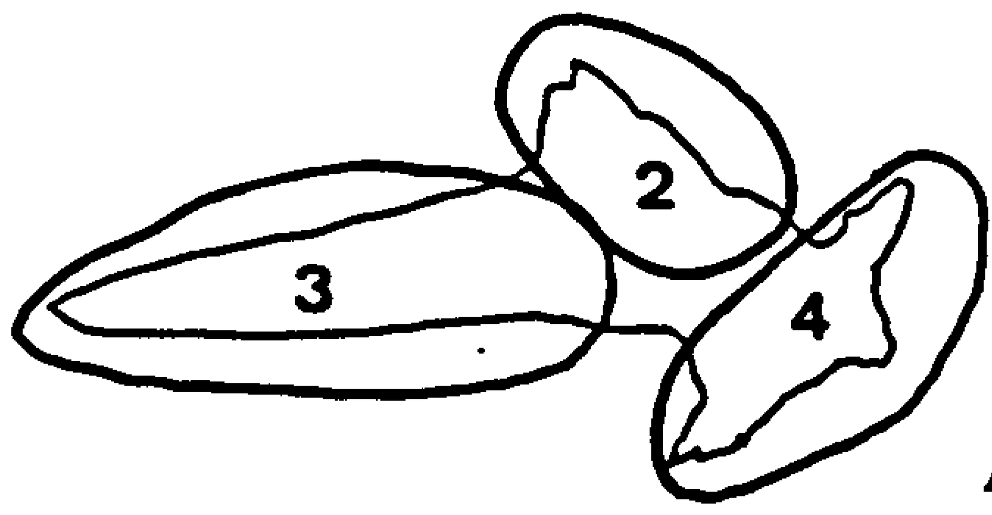
Earl's Bu sample data from LN2? contexts (from this study & Mainland pers comm.)
(bone from samples sorted to >4mm; hand collected bone omitted from correspondence analysis)

Context	Sample	Sample Volume (l)	Shell (g)	Fish Bone (g)	Mammal Bone (g)	Bird Bone (g)
40	70	16		13.2	84.91	
40	71	22	1.3	115.5	76.66	
40	72	15		3.7	7	
40	73	24		118.3	25.14	
40	74	24		6.7	15.75	
40	75	18	1.4	123.8	40.67	
40	76	3		0.8	2.87	
40	77	2.5		43.1	193.3	0.19
40	78	26		47.5	179.1	
40	80	36		137.2	39.46	
40	81	25	1	37.8	176.23	
40	82	28		18.8	78.05	
40	83	24		24.5	12	
40	84	20		29.6	103	
40	85	18		33.5	89	
40	86	26		1.3	2	
40	87	28		3.6	18.52	
40	88	33			103	
40	HAND C.				8.5	
117	94	30		6.4	185	
117	95	39		12	116.23	
117	96	32		10.9	211.78	0.08
117	97	34		71.6	131	
117	98	24		0.1	49	
117	99	44		51.4	214.3	
117	100	26		28.4	561.1	
117	101	34		1.9	35	0.09
117	103	20		4.6	33	
117	104	34		41.4	364.7	
117	105	30		19.7	206.2	
117	HAND C.			17.7	229.7	
118	92	30		28.4	24.11	
126	125	28		10.4	68.57	
145	126	37	0.2	14.9	94.58	
188	151	16		85.1	255.2	
190	157	82	2.1	205.2	1247	
193	166	37		29.2	347.2	
193	168	42	3.2	20.6	190.67	0.71
193	169	47	1.3	13.4	673.3	
193	171	30	1.3	19.6	286.8	
193	172	16	0.3	4.5	16.22	
193	176	32	0.1	21.1	299	
193	179	34	0.1	42.7	718.5	0.05
193	184	1		9.2	10.48	
193	224	24	3	15.2	208.25	
193	226	10	2.1	16.2	154	
193	HAND C.		20	0.5		
194	173	26	0.3	8.9	464.2	
194	240	22		23.3	319.75	0.97
195	188	24.7	1.6	15.6	517.3	
195	189	26		5.3	61.6	
195	190	24	0.1	27	358.9	
195	200	66		23.3	859.6	
195	201			14.9	417.2	
195	202	26		7	152.1	
195	242	19.4		30	56.8	
195	244	30		23.4	193.6	
195	246	30		50	226.56	
195	247	15		14.3	160.4	7.34
195	HAND C.			1.3	1.62	
196	177	31	1.3	3.1	258.01	
196	178	32	3.5	3.3	202.6	0.22
196	185		1	8.5	100.1	0.59
207	129	15		15.5	52.17	
236	318	28.2		10.8	45.6	
327	333	204.2		37.8	152.57	
327	HAND C.			5		
332	337	115.3	0.3	72.3	490.3	9.61
332	339	80.1	0.7	174.2	1461	21.2
332	340	94.2		104.2	1010	2.87
332	HAND C.			17.6	160.52	
334	344	453.2		531.3	3198	38.43
334	345	168.1		157.4	1234	3.66
334	HAND C.			1.1	310.91	2.14
336	347	88.9		62.4	679.4	3.6
336	HAND C.			1.9		
339	352	237.6		406.4	1596.59	25.6
356	350			52.8	124.3	1.1

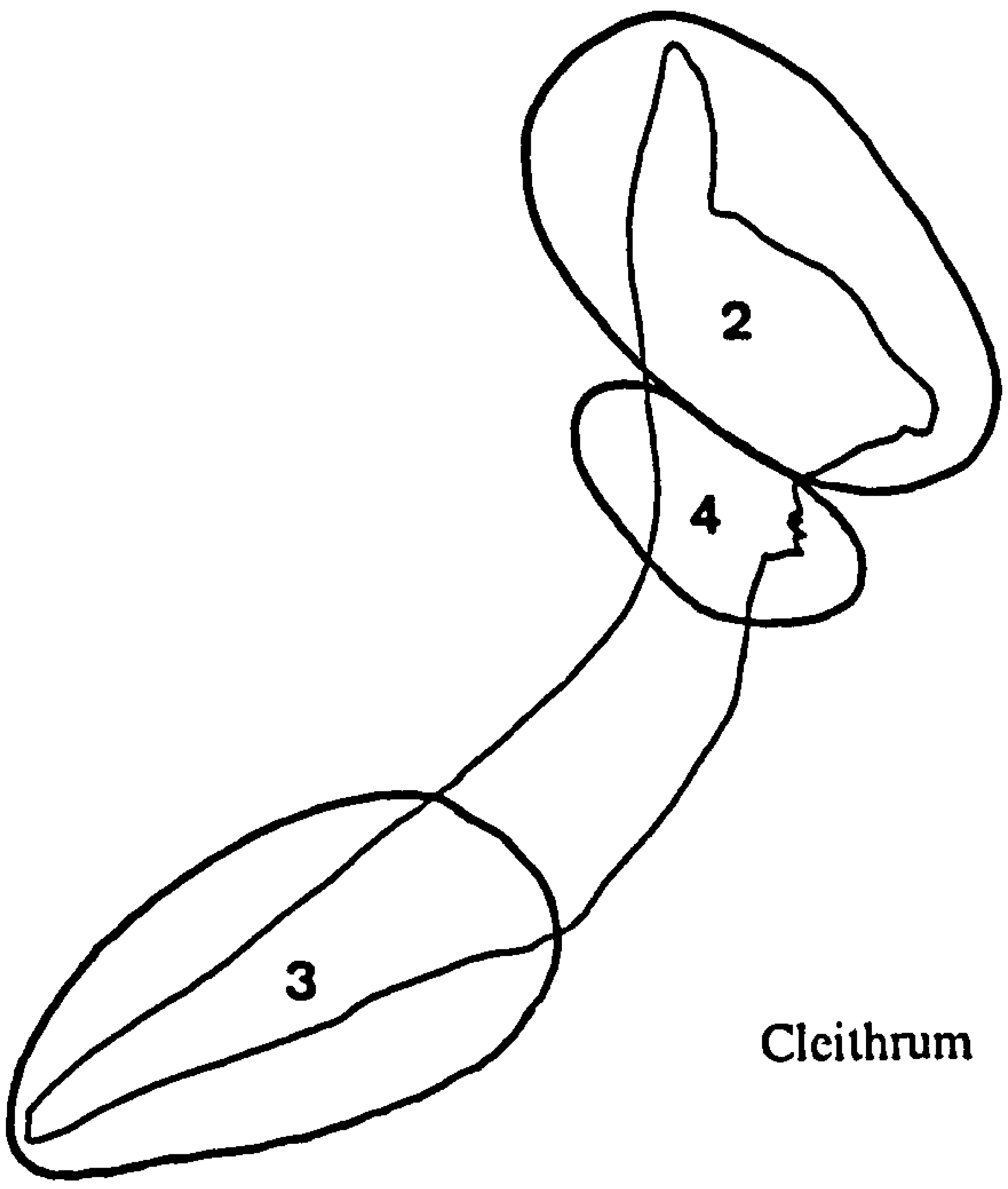
Appendix 8.1

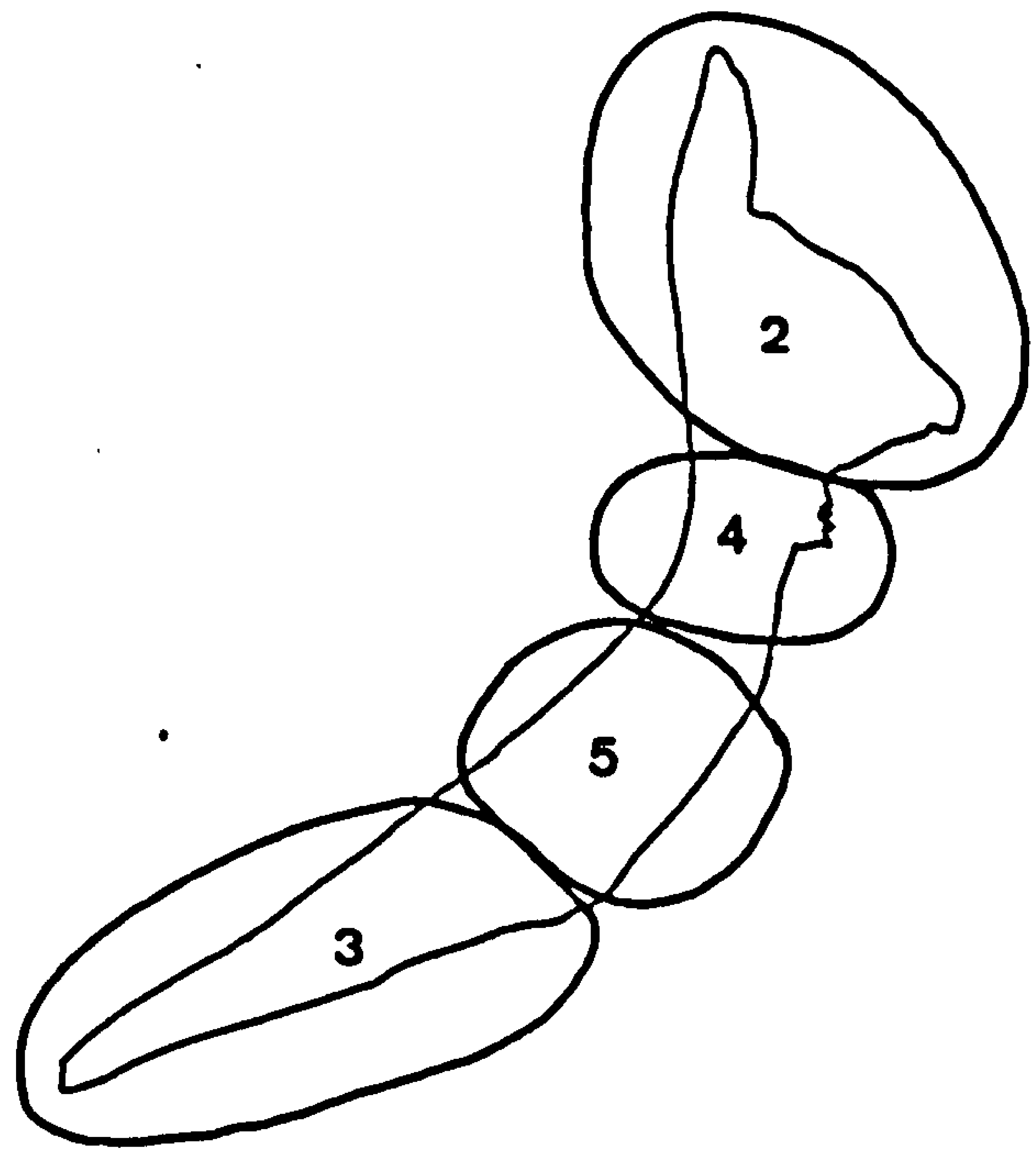
Diagnostic zones for 9 fish elements routinely identified to species

Zones Used | Zones Recommended (if different)

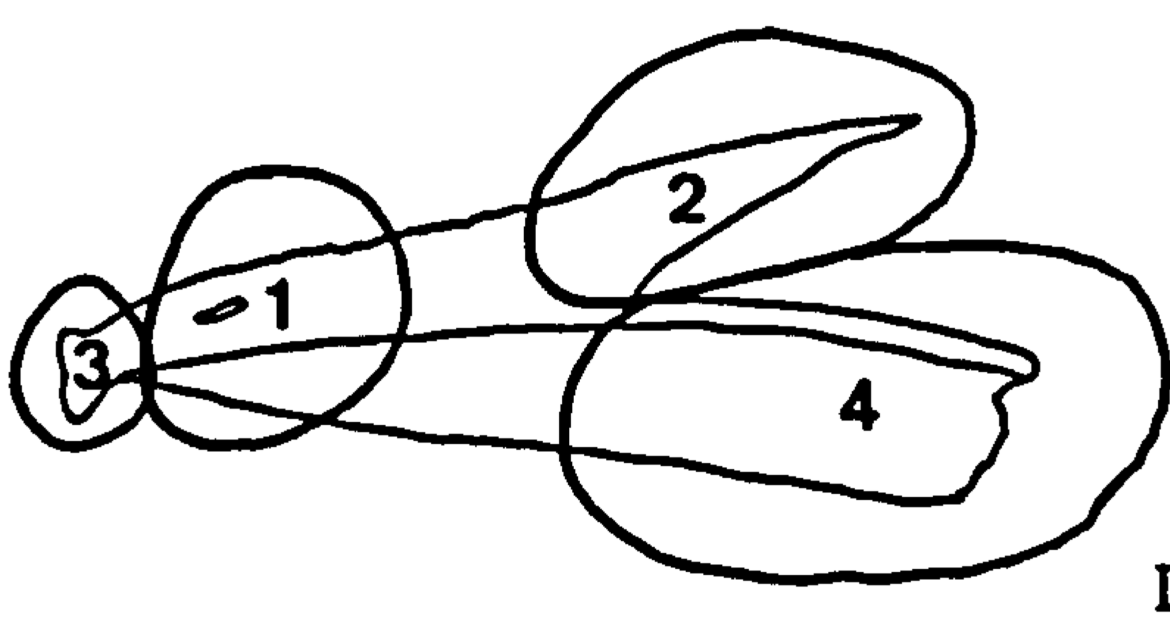


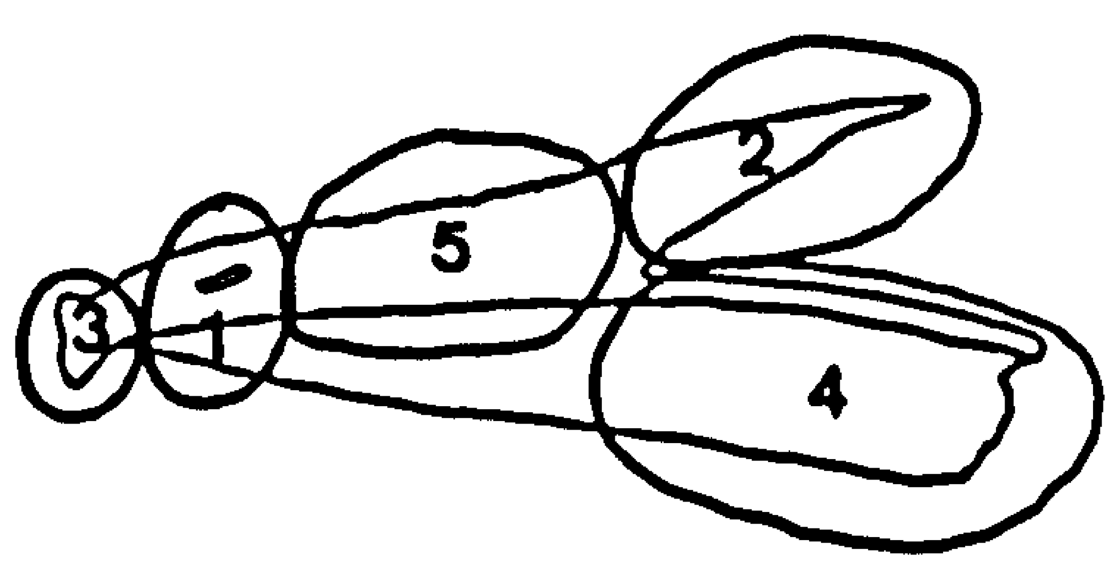
Articular



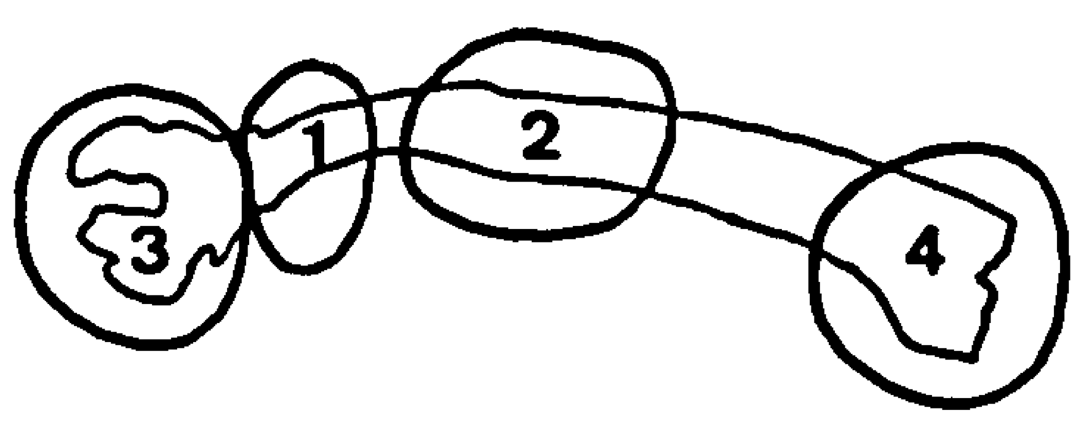


Cleithrum





Dentary

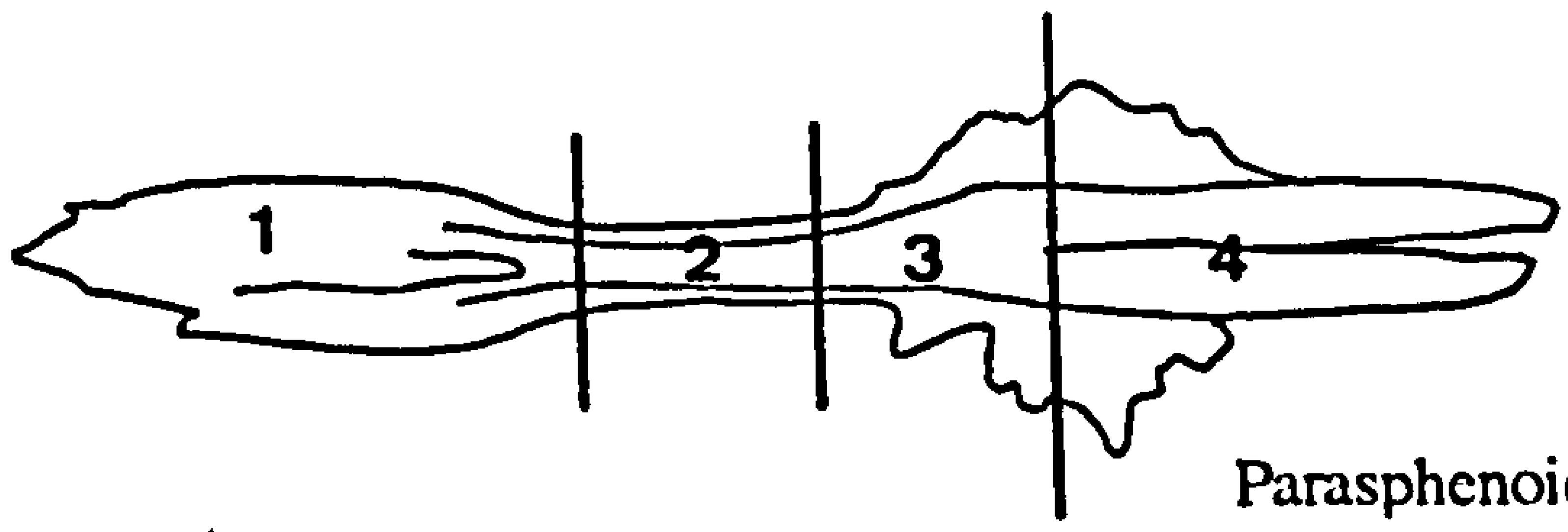


Maxilla

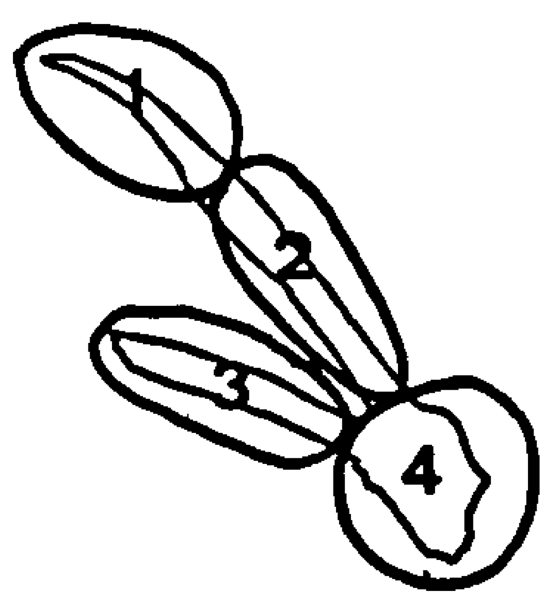
Appendix 8.1

Diagnostic zones for 9 fish elements routinely identified to species

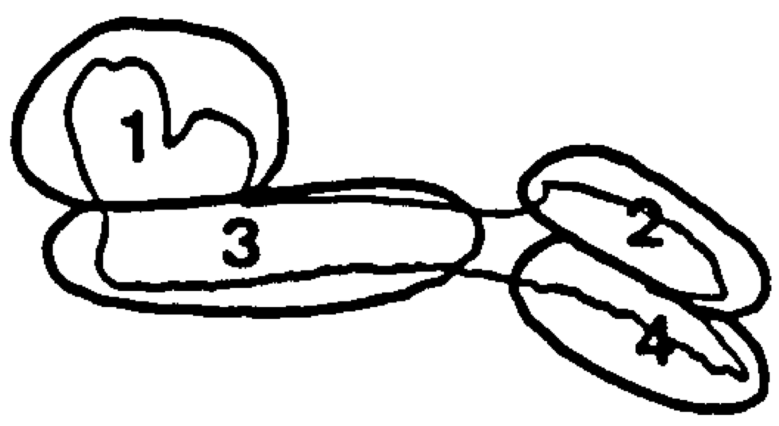
Zones Used | Zones Recommended (if different)

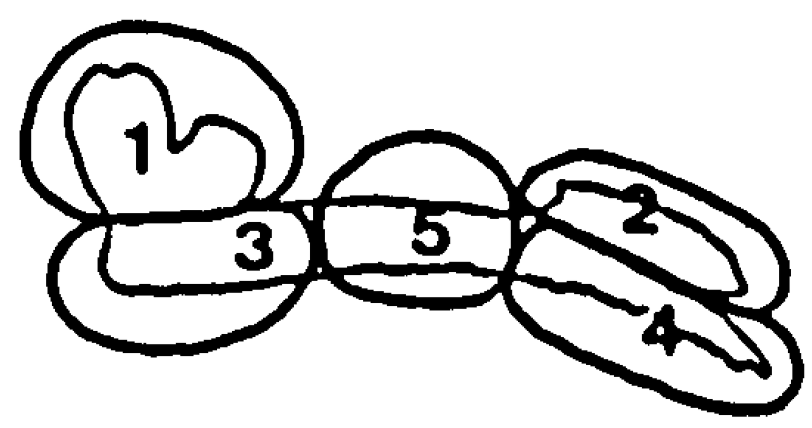


Parasphenoid

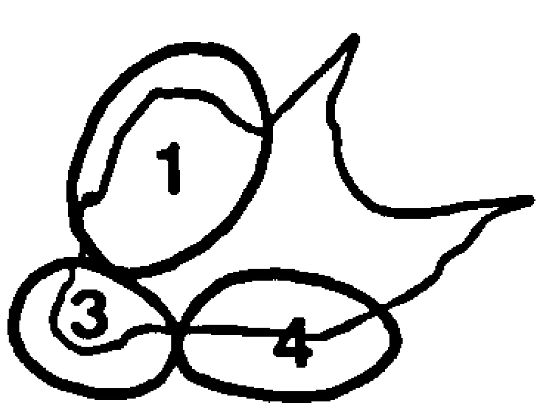


Posttemporal

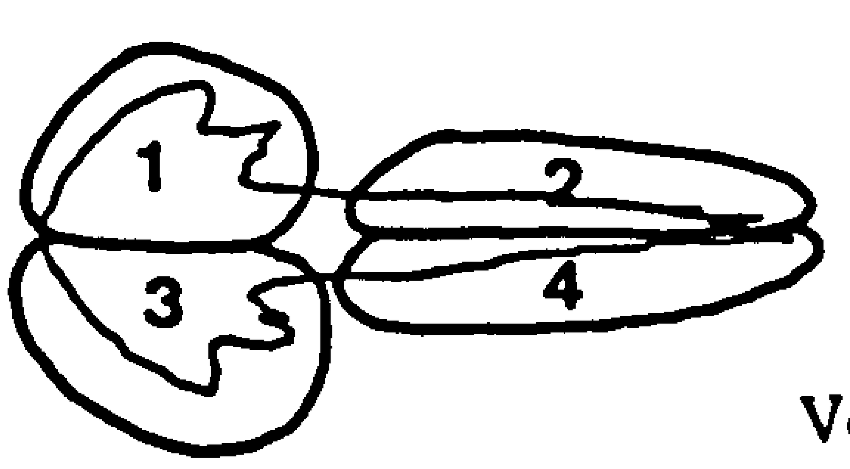




Premaxilla



Quadrate



Vomer

Allen, A. 1995. The Maritime Cultural Landscape of Viking and Late Norse Orkney. Ph.D., University of Durham.

Allen, R. O. 1975. The application of instrumental neutron activation analysis to a study of prehistoric steatite artifacts and source materials. *Archaeometry*. 17, 69-83.

Allen, R. O., Allen, K. K., Holland, C. G. and Fitzhugh, W. W. 1978. Utilisation of soapstone in Labrador by Indians, Eskimos and Norse. *Nature*. 271, 237-239.

Allison, E. P. 1989. The bird bones. In Morris, C. D. *The Birsay Bay Project, Volume 1*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 247-248.

Allison, E. P. forthcoming a. The bird bones. In Buteux, S. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and later periods*.

Allison, E. P. forthcoming b. Bird bone. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Alvey, A. P., Rains, M. J. and Morris, C. D. forthcoming c. The inland excavation areas: Stratigraphy and structures. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Amorosi, T. 1988. Non-metric trait distinction for the family Gadidae and the genus Rattus. Unpublished Report.

Amorosi, T. 1989a. Contributions to the zooarchaeology of Iceland. In Durrenberger, E. P. and Pálsson, G. *The Anthropology of Iceland*. Iowa City, University of Iowa Press, 203-227.

Amorosi, T. 1989b. *A Postcranial Guide to Domestic Neo-natal and Juvenile Mammals*. Oxford, British Archaeological Reports International Series 533.

Amorosi, T. 1991. Icelandic Archaeofauna. A preliminary review. *Acta Archaeologica*. 61, 272-284.

Amorosi, T., Buckland, P. C., Olafsson, G., Sadler, J. P. and Skidmore, P. 1992. Site status and the palaeoecological record: A discussion of results from Bessastadir, Iceland. In Morris, C. D. and Rackham, D. J. *Norse and Later Settlement and Subsistence in the North Atlantic*. Glasgow, University of Glasgow Department of Archaeology, 169-191.

Amorosi, T., Buckland, P. C., Magnússon, K., McGovern, T. H. and Sadler, J. P. 1994. An archaeozoological examination of the midden at Nesstofa, Reykjavik, Iceland. In Luff, R. and Rowley-Conwy, P. *Whither Environmental Archaeology*? Oxford, Oxbow Monograph 38, 69-80.

Andersen, P. S. 1989. The Orkney Church of the twelfth and thirteenth centuries - a stepdaughter of the Norwegian Church. *Collegium Medievale*. 2, 5-25.

Andersen, P. S. 1991. When was regular annual taxation introduced in the Norse Islands of Britain: A comparative study of assessment systems in north-western Europe. *Scandinavian Journal of History*. 16, 73-83.

Anderson, A. O. 1990[1922]. *Early Sources of Scottish History A.D. 500 to 1286 Volumes One and Two*. Stamford, Paul Watkins.

Anderson, J. 1981[1873]. *The Orkneyinga Saga*. Edinburgh, James Thin.

Anderson, P. 1982. *Robert Stewart: Earl of Orkney, Lord of Shetland 1533-1593*. Edinburgh, John Donald.

Anderson, P. 1992. *Black Patie: The life and times of Patrick Stewart, Earl of Orkney, Lord of Shetland*. Edinburgh, John Donald.

Andrew, C. R. W. 1994. The utilisation and exploitation of plants at Norse Age sites in the north of Scotland. M.Sc., University of Glasgow.

Appadurai, A. 1986. Commodities and the politics of value. In Appadurai, A. *The Social Life of Things*. Cambridge, Cambridge University Press, 3-63.

Archibald, M. M. and Woodhead, P. 1975. Mediaeval and modern hoards. *Coin Hoards*. 1, 85-110.

Arnold, C. 1980. Wealth and social structure: A matter of life and death. In Rahtz, P., Dickinson, T. and Watts, L. *Anglo-Saxon Cemeteries 1979*. Oxford, British Archaeological Reports British Series 82, 81-142.

Ashmore, P. 1993. *Jarlshof, A Walk Through the Past*. Edinburgh, Historic Scotland.

Atchley, W. R., Gaskins, C. T. and Anderson, D. 1976. Statistical properties of ratios. I. Empirical results. *Systematic Zoology*. 25, 137-148.

Austin, D. 1990. The 'proper study' of medieval archaeology. In Austin, D. and Alcock, L. *From the Baltic to the Black Sea: Studies in medieval archaeology*. London, Unwin Hyman, 9-42.

Austin, T. 1888. *Two Fifteenth Century Cookery-Books*. London, The Early English Text Society.

Bagge, S. 1991. *Society and Politics in Snorri Sturluson's Heimskringla*. Berkeley, University of California Press.

Baldwin, J. R. 1974. Sea bird fowling in Scotland and Faroe. *Folk Life*. 12, 60-103.

Baldwin, J. R. 1978. Norse influences in sheep husbandry on Foula, Shetland. In Baldwin, J. R. *Scandinavian Shetland, An Ongoing Tradition*? Edinburgh, Scottish Society for Northern Studies, 97-127.

Baldwin, J. R. 1982. Fishing the sellag: Hand netting traditions from Caithness, the Northern and Western Isles. In Baldwin, J. R. *Caithness: A cultural crossroads*. Edinburgh, Edina Press Ltd., 161-212.

Baldwin, J. R. 1986. The Long Treck: Agricultural change and the great northern drove. In Baldwin, J. R. *Firthlands of Ross and Sutherland*. Edinburgh, The Scottish Society for Northern Studies, 183-220.

Bannatyne Club 1855. *The Bannatyne Miscellany Volume III*. Edinburgh, The Bannatyne Club.

Barber, J. forthcoming. Exacavations at St. Magnus Church, Birsay. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Barclay, R. S. 1967. *The Court Books of Orkney and Shetland 1614-1615*. Edinburgh, Scottish History Society.

Barnes, M. P. 1993. The interpretation of the runic inscriptions of Maeshowe. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 349-369.

Barrett, J. H. 1992a. Farmers and fishers in Norse Orkney: The role of foraging in an agricultural economy. M.A., University of Toronto.

Barrett, J. H. 1992b. Robert's Haven. *Discovery & Excavation in Scotland*. 1992, 40-41.

Barrett, J. H. 1992c. Palaeoeconomic investigations at Robert's Haven, Caithness, 1992: A preliminary report. Unpublished report.

Barrett, J. H. 1993. Bone weight, meat yield estimates and cod (*Gadus morhua*): A preliminary study of the weight method. *International Journal of Osteoarchaeology*. 3, 1-18.

Barrett, J. H. 1994. Bone weight and the intra-class comparison of fish taxa. In Van Neer, W. *Fish Exploitation in the Past: Proceedings of the 7th meeting of the ICAZ fish remains working group*. Tervuren, Musee Royal de L'Afrique Centrale, 3-16.

Barrow, G. W. S. 1981. *Kingship and Unity: Scotland 1000-1306*. Edinburgh, Edinburgh University Press.

Batey, C. 1982. The Late Norse site of Freswick. In Baldwin, J. R. *Caithness A Cultural Crossroads*. Edinburgh, Scottish Society for Northern Studies, 45-59.

Batey, C. E. 1984. *Caithness Coastal Survey 1980-82: Dunnet Head to Ousdale*. Durham, Durham University, Department of Archaeology.

Batey, C. E. 1986. Excavations 1975-7: The finds. In Morris, C. D. and Emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 301-374.

Batey, C. E. 1987a. *Freswick Links, Caithness: A re-appraisal of the Late Norse site in its context*. Oxford, British Archaeological Reports.

Batey, C. E. 1987b. Viking and Late Norse Caithness: The archaeological evidence. In Knirk, J. E. *Proceedings of the Tenth Viking Congress*. Oslo, Universitetets Oldsaksamling, 131-148.

Batey, C. E. 1988. A Viking-Age bell from Freswick Links, Caithness. *Medieval Archaeology*. 32, 213-216.

Batey, C. E. 1989a. Excavations beside the Brough Road, Birsay: The artefact assemblage. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 191-229.

Batey, C. E. 1989b. Recent work at Freswick Links, Caithness, Northern Scotland. *Hikuin*. 15, 223-230.

Batey, C. E. 1991a. Archaeological aspects of Norse settlement in Caithness, North Scotland. *Acta Archaeologica*. 61, 29-35.

Batey, C. 1991b. Picts and Vikings in Caithness and Sutherland: A resume. In Karkov, C. and Farrell, R. *Studies in Insular Art and Archaeology,*. Miami, Miami University School of Fine Arts, American Early Medieval Studies 1, 49-59.

Batey, C. E. 1993a. A norse horizontal mill in Orkney. *Review of Scottish Culture*. 8, 20-28.

Batey, C. E. 1993b. The Viking and Late Norse graves of Caithness and Sutherland. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 148-164.

Batey, C. E. and Freeman, C. 1986. Lavacroon, Orphir, Orkney. *Proceedings of the Society of Antiquaries of Scotland*. 116, 285-300.

Batey, C. E. and Morris, C. D. 1983. The Finds. In Hedges, J. W. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 85-108.

Batey, C. E. and Morris, C. D. 1991. Excavations at the Earl's Bu, Orphir, Orkney 1989-90. *University of Durham and University of Newcastle upon Tyne Archaeological Reports 1990*. 45-49.

Batey, C. E. and Morris, C. D. 1992. Earl's Bu, Orphir, Orkney: Excavations of a Norse Horizontal Mill. In Morris, C. D. and Rackham, D. J. *Norse and Later Settlement and Subsistence in the North Atlantic*. Glasgow, University of Glasgow Department of Archaeology.

Batey, C. E., Morris, C. D. and Rackham, D. J. 1984. Freswick Castle, Caithness: Report on rescue excavations carried out in 1979. *Glasgow Archaeological Journal*. 11, 83-118.

Batey, C. E. and Williams, D. F. 1986. Pottery. In Morris, C. D. and Emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 116, 301-374.

Batey, C. E., Freeman, C., Healey, E., Hunter, J. R., Lamden, G. M. and Spearman, R. M. forthcoming a. The artefact assemblage. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Batey, C. E., Lambden, G. and Rogers, I. forthcoming b. Beachview "Studio Site", Area 1 Sub-areas D/E: The artefactual assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Batey, C. E., Freeman, C., Lambden, B., McDonnell, J. G. and Reed, D. forthcoming c. Excavations at Beachview Burnside Area 2: The artefactual assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Batey, C. E., Freeman, C., McDonnell, J. G., Mills, S., Young, A. and Reed, D. forthcoming d. Excavations at Beachview "Studio Site", Area 1: The artefactual assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Baxter, M. J. 1994. *Exploratory Multivariate Analysis in Archaeology*. Edinburgh, Edinburgh University Press.

Beatty, J. 1992. *Sula, the Seabird Hunters of Lewis*. London, Michael Joseph.

Beckman, N. 1912. Annalstudier. *Studier i Nordisk Filologi*. 3, 1-12.

Ben, J. 1805[1529]. Descriptio Insularum Orchadiarum. In Barry, G. *The History of the Orkney Islands*. Edinburgh, Archibald Constable and Company, 433-447.

Bennett, K. D., Boreham, S., Sharp, M. J. and Switsur, V. R. 1992. Holocene history of environment, vegetation and human settlement on Catta Ness, Lunnasting, Shetland. *Journal of Ecology*. 80, 241-273.

Bergsåker, J. 1978. The keeping and milking of sheep in the old subsistence economy of Scandinavia, Iceland and Northern Europe. In Baldwin, J. R. *Scandinavian Shetland, An Ongoing Tradition*? Edinburgh, Scottish Society for Northern Studies, 85-96.

Berry, R. J. 1985. *The Natural History of Orkney*. London, Collins.

Berry, R. J. and Johnston, J. L. 1980. *The Natural History of Shetland*. London, Collins.

Bertelsen, R. 1985a. The medieval Vågan. An Arctic urban experiment. *Archaeology and Environment*. 4, 49-56.

Bertelsen, R. 1985b. *Lofoten ans Vesterålens Historie*. Svolvær, Felleshistorien for Lofoten og Vesterålen.

Bertelsen, R. 1991. A North-east Atlantic perspective. *Acta Archaeologica*. 61, 22-28.

Bertelsen, R. 1992. An archaeological perspective on the Medieval north-south connection. In Anonymous *Medieval Europe 1992 Exchange and Trade Pre-Printed Papers*. York, Medieval Europe 1992, 177-184.

Bertelsen, R., Buko, A., Fossnes, A., Hood, J., Kobylinski, Z., Lind, K. and Urbanczyk, P. 1987. The Storvågan Project 1985-86. *Norwegian Archaeological Review*. 20, 51-55.

Bertelsen, R. and Lamb, R. G. 1993. Settlement mounds in the North Atlantic. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 544-553.

Bibire, P. A. 1984. 'Few know an earl in fishing-clothes'. In Crawford, B. E. *Essays in Shetland History*. Lerwick, The Shetland Times Ltd., 82-98.

Bibire, P. 1988. The poetry of Earl Rognvald's court. In Crawford, B. E. *St Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 208-240.

Bigelow, G. F. 1984. Subsistence in Late Norse Shetland: An investigation into a northern island economy of the middle ages. Ph.D, Cambridge.

Bigelow, G. F. 1985. Sandwick, Unst and Late Norse Shetland economy. In Smith, B. *Shetland archaeology: new work in the 1970s*. Lerwick, The Shetland Times Ltd., 95-127.

Bigelow, G. F. 1987. Domestic architecture in Medieval Shetland. *Review of Scottish Culture*. 3, 23-38.

Bigelow, G. F. 1989. Life in medieval Shetland: An archaeological perspective. *Hikuin*. 15, 183-192.

Bigelow, G. F. 1992. Issues and Prospects in Shetland Norse Archaeology. In Morris, C. D. and Rackham, D. J. *Norse and Later Settlement and Subsistence in the North Atlantic*. Glasgow, University of Glasgow, Department of Archaeology, 9-32.

Binford, L. R. and Bertram, J. B. 1977. Bone frequencies - and attritional processes. In Binford, L. R. *For theory building in archaeology*. London, Academic Press, 77-153.

Bintliff, J. and Snodgrass, A. 1992. Off-site pottery distributions: A regional and interregional perspective. *Current Anthropology*. 29, 506-513.

Blackmore, L. and Vince, A. 1994. Medieval pottery from south east England found in the Bryggen excavations 1955-68. In Herteig, A. E., Helle, K. and Indrelid, S. *The Bryggen Papers Supplementary Series No 5*. Bergen, Scandinavian University Press, 9-160.

Blindheim, C. 1975. Kaupang by the Viks Fjord in Vestfold: Excavations and research. In Herteig, A. E., Liden, H.-E. and Blindheim, C. *Archaeological Contributions to the Early History of Urban Communities in Norway*. Oslo, Universiteforlaget, 125-153.

Blindheim, C. 1978. Trade problems in the Viking Age. Some reflections on Insular metalwork found in Norwegian Graves of the Viking Age. In Andersson, T. and Sandred, K. I. *The Vikings: Proceedings of the symposium of the Faculty of Arts of Uppsala University June 6-9, 1977*. Stockholm, Almqvist & Wiksell International, 166-176.

Blindheim, C. 1982. Commerce and trade in Viking Age Norway. *Norwegian Archaeological Review*. 15, 8-17.

Bloch, D. 1989-90. Studies on the long-finned pilot whale in the Faroes Islands, 1976-86. *Fródskaparrit*. 38-39, 35-61.

Boddington, A. 1987. Raunds, Northamptonshire: Analysis of a country churchyard. *World Archaeology*. 18, 411-425.

Bohannan, P. and Dalton, G. 1962. Introduction. In Bohannan, P. and Dalton, G. *Markets in Africa*. Evanston, Northwestern University Press.

Bond, J. M. 1994. Change and continuity in an island system: The palaeoeconomy of Sanday, Orkney. Ph.D., University of Bradford.

Bond, J. M. forthcoming. The mammal bone from Pool, Orkney.

Bond, J. M. and Hunter, J. R. 1987. Flax-growing in Orkney from the Norse period to the 18th century. *Proceedings of the Society of Antiquaries of Scotland*. 117, 175-181.

Boyle, P., Pierce, G. and Watt, J. 1992. Guide for the Identification of Premaxillae and Vertebrae of the Fish from the North Sea. Unpublished report.

Brady, K. J. and Morris, C. D. 1995. *Brough of Birsay, Orkney, Archaeological Examination July, 1993: Site data report*. Glasgow, University of Glasgow Viking and Early Settlement Archaeological Research Project.

Bramwell, D. 1976-1977. Bird and vole bones from Buckquoy, Orkney. In Ritchie, A. Excavation of Pictish and Viking-age farmsteads at Buckquoy, Orkney. *Proceedings of the Society of Antiquaries of Scotland*. 108, 174-227.

Brand, J. 1883[1701]. *A Brief Description of Orkney, Zetland, Pightland-Firth and Caithness*. Edinburgh, William Brown.

Brereton, G. E. and Ferrier, J. M. 1981. *Le Menagier de Paris*. Oxford, Oxford University Press.

Brinkhuizen, D. C. 1994. Some notes on fish remains from the late 16th century merchant vessel Scheurrak SO1. In Van Neer, W. *Fish Exploitation in the Past: Proceedings of the 7th meeting of the ICAZ fish remains working group.* Tervuren, Musee Royal de L'Afrique Centrale, 197-206.

Brøgger, A. W. 1929. *Ancient Immigrants: A history of the Norse settlement of Scotland.* Oxford, The Clarendon Press.

Brøgger, A. W. 1930. *Den Norske Bosetningen På Shetland-Orknøyene: Studier og resultater.* Oslo, Jacob Dyburad.

Bron, J. E. 1987. An investigation of the survival and fragmentation of fishbone elements subjected to mechanical stress, with particular reference to the interpretation of archaeological fishbone assemblages. M.Sc., University College London - Institute of Archaeology.

Brothwell, D. 1977. On a mycoform stone structure in Orkney, and its relevance to possible further interpretations of so-called souterrains. *Bulletin of the Institute of Archaeology.* 14, 179-190.

Bruce, J. 1907. Notice of the excavation of a broch at Jarlshof, Sumburgh, Shetland. *Proceedings of the Society of Antiquaries of Scotland.* 41, 11-33.

Bruhn, O. 1993. Earl Rognvald and the rise of saga literature. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age.* Edinburgh, Edinburgh University Press, 240-247.

Buckland, P. C. and Perry, D. W. 1989. Ectoparasites of sheep from Stóraborg, Iceland and their interpretation. Piss, parasites and people, a paleoecological perspective. *Hikuin.* 15, 37-46.

Buckland, P. C., Gerrard, A. J., Sadler, J. P. and Sveinbjarnardóttir, G. 1994. Farmers, farm mounds and environmental change. In Stötter, J. *Environmental Change in Iceland.* Munich, Münchener Geographische Abhandlungen, 7-30.

Bugge, A. 1898. Handelen mellem England og Norge indtil begynnelsen af det 15de aarhundre. *Historisk Tidsskrift.* 4.

Burnett, G. 1878. *The Exchequer Rolls of Scotland Volume II.* Edinburgh, H.M. General Register House.

Burnett, G. 1880. *The Exchequer Rolls of Scotland Volume III.* Edinburgh, H.M. General Register House.

Buteux, S. forthcoming. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and later periods.*

Butler, V. L. 1993. Natural versus cultural salmonid remains: Origin of the Dalles Roadcut bones, Columbia River, Oregon, U.S.A. *Journal of Archaeological Science.* 20, 1-24.

Butler, V. L. and Chatters, J. C. 1994. The role of bone density in structuring prehistoric salmon bone assemblages. *Journal of Archaeological Science.* 21, 413-424.

Buttler, S. 1989. Steatite in Norse Shetland. *Hikuin.* 15, 193-206.

Buttler, S. 1991. Steatite in the Norse North Atlantic. *Acta Archaeologica.* 61, 228-232.

Byock, J. L. 1993. *Medieval Iceland: Society, sagas and power*. Enfield Lock, Middlesex, Hisarlik Press.

Calder, J. T. 1887. *Sketch of the Civil and Traditional History of Caithness*. Wick, William Rae.

Callmer, J. 1977. *Trade Beads and Bead Trade in Scandinavia ca. 800-1000 A.D.* Lund, CWK Gleerup.

Cambridge, E. 1988. The architectural context of the romanesque cathedral at Kirkwall. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 111-126.

Cant, R. G. 1984. Settlement, society and church organisation in the Northern Isles. In Fenton, A. and Pálsson, H. *The Northern and Western Isles in the Viking World.* Edinburgh, John Donald, 169-179.

Carbone, V. A. and Keel, B. C. 1985. Preservation of plant and animal remains. In R.I. Gilbert, J. and Mielke, J. H. *The Analysis of Prehistoric Diets*. London, Academic Press, 1-19.

Carr, C. 1984. The nature of organization of intrasite archaeological records and spatial analytic approaches to their investigation. In Schiffer, M. B. *Advances in Archaeological Method and Theory Volume 7.* London, Academic Press, Inc., 103-222.

Carus-Wilson, E. M. 1933. The Iceland Trade. In Power, E. and Postan, M. M. *Studies in English Trade in the Fifteenth Century*. London, George Routledge & Sons Ltd., 155-182.

Casteel, R. W. 1976. Comparison of column and whole unit samples for recovering fish remains. *World Archaeology*. 8, 192-196.

Casteel, R. W. 1978. Faunal assemblages and the "wiegemethode" or weight method. *Journal of Field Archaeology*. 5, 71-77.

Cerón-Carrasco, R. 1993. The fish remains from St. Boniface. AOC (Scotland) unpublished Report.

Cerón-Carrasco, R. 1994. The investigation of fish remains from an Orkney farm mound. In Van Neer, W. *Fish Explöitation in the Past: Proceedings of the 7th meeting of the ICAZ fish remains working group*. Tervuren, Musee Royal de L'Afrique Centrale, 207-210.

Cerón-Carrasco, R. n.d. Upper Scalloway, Shetland: The fish bone remains. AOC (Scotland) unpublished Report.

Cerón-Carrasco, R. forthcoming. The fish remains. In Lowe, C. *Excavations at St. Boniface, Papa Westray, Orkney*.

Champion, T. C. 1990. Medieval archaeology and the tyranny of the historical record. In Austin, D. and Alcock, L. *From the Baltic to the Black Sea: Studies in medieval archaeology*. London, Unwin Hyman, 79-95.

Chaplin, R. E. 1971. *The Study of Animal Bones from Archaeological Sites*. New York, Seminar Press.

Charman, D. J. 1994. Late-glacial and Holocene vegetation history of the Flow Country, northern Scotland. *New Phytologist*. 127, 155-168.

Chesnutt, M. 1985. The Dalhousie Manuscript of the *Historia Norvegiae*. In *Opuscula 8. Bibliotheca Arnamagnæana, 37*. Copenhagen, Reitzel, 54-95.

Childe, V. G. 1943. Another late Viking house at Freswick, Caithness. *Proceedings of the Society of Antiquaries of Scotland*. 77, 5-17.

Christensen, A. E. 1985. Boat finds from Bryggen. In Hagen, A., Helle, K. and Herteig, A. *The Bryggen Papers*. Bergen, Universitetsforlaget AS, 47-272.

Clarke, H. and Ambrosiani, B. 1991. *Towns in the Viking Age*. Leicester, Leicester University Press.

Clark, J. G. D. 1951. Folk-culture and the study of European prehistory. In Grimes, W. F. *Aspects of Archaeology*. London, Edwards, 49-65.

Clason, A. T. and Prummel, W. 1977. Collecting, sieving and archaeozoological research. *Journal of Archaeological Science*. 4, 171-175.

Close, A. 1922. *Scotland to Iceland Chart*. London, Edward Stanford Ltd.

Clouston, J. S. 1914. *Records of the Earldom of Orkney*. Edinburgh, The Scottish History Society.

Clouston, J. S. 1931. *Early Norse Castles*. Kirkwall, W.R. MacKintosh.

Clouston, J. S. 1932. *A History of Orkney*. Kirkwall, W.R. MacKintosh.

Clutton-Brock, J. 1979a. Report of the mammalian remains other than rodents from Quanterness. In Renfrew, C. *Investigations in Orkney*. London, The Society of Antiquaries of London, 112-149.

Clutton-Brock, J. 1979b. Animal remains from the round house. In Renfrew, C. *Investigations in Orkney*. London, The Society of Antiquaries of London, 192-194.

Clutton-Brock, J. 1981. *Domesticated Animals*. London, British Museum (Natural History).

Clutton-Brock, J. and MacGregor, A. 1988. An end to medieval reindeer in Scotland. *Proceedings of the Society of Antiquaries of Scotland*. 118, 23-35.

Coles, J. 1971. The early settlement of Scotland: excavations at Morton, Fife. *Proceedings of the Prehistoric Society*. 27, 284-366.

Colley, S. M. 1983a. The role of fish bone studies in economic archaeology with special reference to the Orkney Isles. Ph.D, University of Southampton.

Colley, S. M. 1983b. Interpreting prehistoric fishing strategies: An Orkney case study. In Grigson, C. and Clutton-Brock, J. *Animals and archaeology: 2 shell middens fishes and birds*. Oxford, British Archaeological Reports, 157-171.

Colley, S. M. 1983c. Marine resource exploitation. In Hedges, J. W. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 10, 73-124.

Colley, S. M. 1984. Some methodological problems in the interpretation of fish remains from archaeological sites in Orkney. In Desse-Berset, N. *2nd fish osteoarchaeology meeting*. Paris, Centre National de la Recherche Archeologique, 117-131.

Colley, S. M. 1986. Site formation and archaeological fish remains. An ethnohistorical example from the Northern Isles, Scotland. In Brinkhuizen, D. C. and Clason, A. T. *Fish and archaeology.* British Archaeological Reports, 34-41.

Colley, S. M. 1988. Fish remains from excavations at Tuquoy, Westray, Orkney, 1982-3. Unpublished report submitted to O. Owen, Historic Scotland.

Colley, S. M. 1989. The fish bones. In Morris, C. D. *The Birsay Bay Project, Volume 1.* Durham, University of Durham Department of Archaeology Monograph Series Number 1, 248-259.

Colley, S. M. 1990. The analysis and interpretation of archaeological fish remains. In Schiffer, M. B. *Archaeological Method and Theory.* Tucson, The University of Arizona Press, 207-253.

Convention of Royal Burghs 1878. *Extracts from the Records of the Convention of the Royal Burghs of Scotland.* Edinburgh, William Paterson.

Cook, S. F. and Treganza, A. E. 1956. The quantitative investigation of Indian mounds. In Gifford, E. W., Kroeber, A. L., Lowie, R. H., McCown, T. D., Mandelbaum, D. G. and Olson, R. L. *University of California Publications in American Archaeology and Ethnology, Volume 40, 1942-1953.* Los Angeles, University of California Press, 223-259.

Coppock, J. T. 1976. *An Agricultural Atlas of Scotland.* Edinburgh, John Donald.

Corbet, G. B. and Southern, H. 1977. *The Handbook of British Mammals, 2nd edition.* Oxford, Blackwell.

Corbet, G. B. and Harris, S. 1991. *The Handbook of British Mammals, 3rd edition.* Oxford, Blackwell.

Coull, J. R. 1972. *The Fisheries of Europe, An Economic Geography.* London, G. Bell & Sons, Ltd.

Coull, J. R., Goodlad, J. H. and Sheves, G. T. 1979. *The Fisheries in the Shetland Area: A study in conservation and development.* Aberdeen, Department of Geography, University of Aberdeen.

Coull, K. A., Jermyn, A. S., Newton, A. W., Henderson, G. I. and Hall, W. B. 1989. *Length/Weight Relationships for 88 Species of Fish Encountered in the North East Atlantic.* Aberdeen, Department of Agriculture and Fisheries for Scotland, Marine Laboratory.

Cowan, E. 1973. What is Orkneyinga Saga about? *Northern Studies.* 2, 19-22.

Cowan, E. 1982. Caithness in the Sagas. In Baldwin, J. R. *Caithness A Cultural Crossroads.* Edinburgh, Scottish Society for Northern Studies, 25-44.

Cowan, E. 1990. Norwegian sunset - Scottish dawn, Hakon IV and Alexander III. In Reid, N. *Scotland in the Reign of Alexander III.* Edinburgh, John Donald, 103-131.

Cowan, I. B. 1971. Two early Scottish taxation rolls. *The Innes Review.* 22, 6-11.

Crabtree, P. 1990. Zooarchaeology and complex societies: Some uses of faunal analysis for the study of trade, social status, and ethnicity. In Schiffer, M. B. *Archaeological Method and Theory Volume* 2. Tucson, University of Arizona Press, 155-205.

Crawford, B. 1974. Peter's Pence in Scotland. In Barrow, G. W. S. *The Scottish Tradition: Essays in honour of Ronald Gordon Cant*. Edinburgh, Scottish Academic Press, 14-22.

Crawford, B. E. 1975. Viking Graves. In McNeill, P. and Nicholson, R. *An Historical Atlas of Scotland c.400-c.1600*. St. Andrews, Conference of Scottish Medievalists, 16-17.

Crawford, B. E. 1982. Scots and Scandinavians in medieval Caithness: A study of the period 1266-1375. In Baldwin, J. R. *Caithness a Cultural Crossroads*. Edinburgh, Scottish Society for Northern Studies, 61-74.

Crawford, B. E. 1985a. The Biggings, Papa Stour - A multi-disciplinary investigation. In Smith, B. *Shetland Archaeology: New work in the 1970s*. Lerwick, The Shetland Times Ltd., 128-158.

Crawford, B. E. 1985b. The earldom of Caithness and the kingdom of Scotland, 1150-1266. In Stringer, K. J. *Essays on the Nobility of Medieval Scotland*. Edinburgh, John Donald, 25-43.

Crawford, B. E. 1986. The making of a frontier: The firtlands from the ninth to twelfth centuries. In Baldwin, J. R. *Firthlands of Ross and Sutherland*. Edinburgh, The Scottish Society for Northern Studies, 33-46.

Crawford, B. E. 1987. *Scandinavian Scotland*. Leicester, Leicester University Press.

Crawford, B. E. 1991a. Excavations at The Biggings, Papa Stour, Shetland. *Acta Archaeologica*. 61, 36-43.

Crawford, B. E. 1991b. The ancient earldoms. Paper presented at Some Explorations in the Ancient Earldoms of Caithness and Orkney, Stromness, Orkney.

Crawford, B. E. 1993. Norse earls and Scottish bishops in Caithness: A clash of cultures. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 129-147.

Crawford, I. A. 1981. War or Peace - Viking colonization in the Northern and Western Isles of Scotland reviewed. In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 259-270.

Crone, A. n.d. Tuquoy: The waterlogged wood. Unpublished report submitted to O. Owen, Historic Scotland.

Crosby, D. D. B. and Mitchell, J. G. 1987. A survey of British metamorphic hone stones of the 9th to 15th centuries AD in the light of Potassium-Argon and Natural Remanent Magnetization Studies. *Journal of Archaeological Science*. 14, 483-506.

Cruden, S. 1988. The founding and building of the twelfth-century Cathedral of St Magnus. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 78-87.

Curle, A. O. 1939. A Viking settlement at Freswick, Caithness. Report on excavations carried out in 1937 and 1938. *Proceedings of the Society of Antiquaries of Scotland*. 73, 71-110.

Curle, A. O. 1954. Dwellings of the Viking Period. In Curle, A. O., Olsen, M. and Shetelig, H. *Civilisation of the Viking Settlers in Relation to their Old and New Countries, Viking Antiquities in Great Britain and Ireland Part VI*. Oslo, H. Aschehoug & Co., 7-63.

Curle, C. L. 1982. *Pictish and Norse Finds from the Brough of Birsay 1934-74.* Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 1.

Cutting, C. L. 1955. *Fish Saving*. London, Leonard Hill.

Dalland, M. 1992. Scar, Sanday, Viking boat grave. *Discovery & Excavation in Scotland*. 1992, 81-82.

Dansgaard, W., Johnsen, S. J., Reeh, N., Gundestrup, N., Clausen, H. B. and Hammer, C. U. 1975. Climatic changes, Norsemen and modern man. *Nature*. 155, 24-28.

Dasent, G. W. 1894a. *The Orkneyingers' Saga*. London, HMSO.

Dasent, G. W. 1894b. *The Saga of Hacon*. London, HMSO.

Davidson, D. A., Harkness, D. D. and Simpson, I. A. 1986. The formation of farm mounds on the island of Sanday, Orkney. *Geoarchaeology*. 1, 45-60.

Davidson, D. A. and Jones, R. 1985. The Environment of Orkney. In Renfrew, C. *The Prehistory of Orkney*. Edinburgh, Edinburgh University Press, 10-35.

Davis, M. and Sheridan, A. 1993. Scottish prehistoric 'jet' jewellery: Some new work. *Proceedings of the Society of Antiquaries of Scotland*. 123, 455-456.

Davis, S. J. M. 1987. *The Archaeology of Animals*. London, B. T. Batsford Ltd.

Davis, S. J. M. 1991. Faunal remains from Closegate I & II, Newcastle, Tyne and Wear, 1988 & 1990 excavations. *Ancient Monuments Laboratory Report*. 81/91, London. English Heritage.

Dennel, R. 1972. The interpretation of plant remains: Bulgaria. In Higgs, E. S. *Papers in Economic Prehistory*. Cambridge, Cambridge University Press, 149-159.

Dennel, R. 1976. The economic importance of plant resources represented on archaeological sites. *Journal of Archaeological Science*. 3, 229-247.

Ditchburn, D. 1990. A note on Scandinavian trade with Scotland in the later middle ages. In Simpson, G. *Scotland and Scandinavia 800-1800*. Edinburgh, John Donald, 73-89.

Dixon, P. 1986. *Excavations in the Fishing Town of Eyemouth 1982-1984*. Edinburgh, Borders Architects Group.

Dennis, A., Foote, P. and Perkins, R. 1980. *Laws of Early Iceland Grágás: The Codex Regius of Grágás with material from other manuscripts*. Winnipeg, University of Manitoba Press.

Dickson, C. 1983. The macroscopic plant remains. In Hedges, J. W. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 10, 73-124.

Dickson, C. n.d. The Biggins, Papa Stour, Shetland: Plant remains. Unpublished report.

Doherty, C. 1980. Exchange and trade in early medieval Ireland. *Journal of the Royal Society of Antiquaries of Ireland*. 110, 67-89.

Dolley, M. 1967-1968. A Viking Age coin of Norway discovered in Shetland. *Proceedings of the Society of Antiquaries of Scotland*. 100, 193-195.

Dolley, M. 1981. The palimpsest of Viking settlement on Man. In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 173-182.

Donaldson, A. M. 1982. Charcoal. In Curle, C. L. *Pictish and Norse Finds from the Brough of Birsay 1934-74*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 1, 138.

Donaldson, A. M. 1984. Botanical remains. In Batey, C. E., Morris, C. D. and Rackham, D. J. Freswick Castle, Caithness: Report on rescue excavations carried out in 1979. *Glasgow Archaeological Journal*. 11, 83-118.

Donaldson, A. M. 1986a. Carbonised seeds and grains with identifications. In Hunter, J. R. *Rescue Excavations on the Brough of Birsay 1974-82*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 4, 216-219.

Donaldson, A. M. 1986b. Charcoal remains. In Hunter, J. *Rescue Excavations on the Brough of Birsay 1974-82*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 4, 219-220.

Donaldson, A. M. 1986c. Wood and Charcoal. In Morris, C. D. and Emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 301-374.

Donaldson, A. M., Morris, C. D. and Rackham, D. J. 1981. The Birsay Bay project: Preliminary investigations into the past exploitation of the coastal environment at Birsay, Mainland, Orkney. In Brothwell, D. and Dimbleby, G. *Environmental Aspects of Coasts and Islands*. Oxford, British Archaeological Reports International Series 94, 67-86.

Donaldson, A. M. and Nye, S. 1989. The botanical remains. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 262-267.

Donaldson, G. 1954. *The Court Book of Shetland*. Edinburgh, The Scottish Record Society.

Donaldson, G. 1974. *Scottish Historical Documents*. Edinburgh, Scottish Academic Press.

Donaldson, G. 1988. The Contemporary Scene. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 1-10.

Donaldson, G. 1990. *A Northern Commonwealth: Scotland and Norway*. Edinburgh, Saltire.

Dorian, N. C. 1981. *Language Death*. Philadelphia, University of Pennsylvania Press.

Driscoll, S. 1990. Rescue excavations of a prehistoric settlement and Viking Age/Medieval cemetery at John O'Groats, 1989. *Glasgow Archaeological Journal*. 16, 29-37.

Dry, F. T. and Robertson, J. S. 1982. *Soil and Land Capability for Agriculture, Orkney and Shetland*. Aberdeen, The Macaulay Institute for Soil Research.

Duby, G. 1974. *The Early Growth of the European Economy*. Ithaca, New York, Cornell University Press.

Duncan, A. A. M. and Brown, A. L. 1957. Argyll and the Isles in the earlier Middle Ages. *Proceedings of the Society of Antiquaries of Scotland.* 90, 193-194.

Dunnell, R. C. and Dancey, W. S. 1984. The siteless survey: A regional scale data collection strategy. In Schiffer, M. B. *Advances in Archaeological Method and Theory Volume 6*. Orlando, Academic Press, Inc., 267-287.

Durrenberger, E. P. 1988. Chiefly Consumption in Commonwealth Iceland. *Northern Studies*. 25, 108-120.

Durrenberger, E. P. 1989. Anthropological perspectives on the Commonwealth Period. In Durrenberger, E. P. and Pálsson, G. *The Anthropology of Iceland*. Iowa City, University of Iowa Press, 228-246.

Durrenberger, E. P. 1991. Production in Medieval Iceland. *Acta Archaeologica*. 61, 14-21.

Earle, T. 1991a. *Chiefdoms: Power, economy and ideology*. Cambridge, Cambridge University Press.

Earle, T. 1991b. The evolution of chiefdoms. In Earle, T. *Chiefdoms: Power, economy and ideology*. Cambridge, Cambridge University Press, 1-15.

Earle, T. K. and Ericson, J. E. 1977. *Exchange Systems in Prehistory*. London, Academic Press.

Ebert, J. I. 1992. *Distributional Archaeology*. Albuquerque, University of New Mexico Press.

Edwards, R. forthcoming. Norse settlement. In Buteux, S. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and Later Periods*. 1-26.

Ekholm, K. and Friedman, J. 1993. "Capital" imperialism and exploitation in ancient world systems. In Frank, A. G. and Gills, B. K. *The World System: Five hundred years or five thousand*. London, Routledge, 59-80.

Enghoff, I. B. 1994. Fishing in Denmark during the Ertebølle Period. *International Journal of Osteoarchaeology*. 4, 65-96.

Ericson, J. E. and Earle, T. K. 1982. *Contexts for Prehistoric Exchange*. London, Academic Press.

Evans, J. G. and Spencer, P. 1976-1977. The mollusca and environment, Buckquoy, Orkney. In Ritchie, A. Excavation of Pictish and Viking-age farmsteads at Buckquoy, Orkney. *Proceedings of the Society of Antiquaries of Scotland.* 108, 215-219.

Ewan, E. 1990. *Townlife in Fourteenth-Century Scotland.* Edinburgh, Edinburgh University Press.

Fanning, T. 1983. Some aspects of the bronze ringed pin in Scotland. In O'Connor, A. and Clarke, D. V. *From the Stone Age to the 'Forty-Five.* Edinburgh, John Donald, 324-342.

Faulkner, A. 1985. Archaeology of the cod fishery: Damariscove Island. *Historical Archaeology.* 19, 57-86.

Fawcett, R. 1988. Kirkwall Cathedral: An architectural analysis. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 88-110.

Fell, C. E. 1984. Ohthere's Account. In Lund, N. *Two Voyagers at the Court of King Alfred*. York, William Sessions Limited, 18-22.

Fellows-Jensen, G. 1984. Viking settlement in the Northern and Western Isles - the place name evidence as seen from Denmark and the Danelaw. In Fenton, A. and Pálsson, H. *The Northern and Western Isles in the Viking World*. Edinburgh, 146-168.

Fellows-Jensen, G. 1987. The Vikings' relationship with Christianity in the British Isles: The evidence of place-names containing the element *kirkja*. In Knirk, J. E. *Proceedings of the Tenth Viking Congress*. Oslo, Universitetets Oldsaksamling, 295-308.

Fellows-Jensen, G. 1993. Tingwall: The significance of the name. Paper presented at Scottish Society for Northern Studies 21st Annual Conference, Shetland, 6-11 July, 1993.

Fenton, A. 1978. *The Northern Isles: Orkney and Shetland.* Edinburgh, John Donald Publishers Ltd.

Fenton, A. 1986a. Food and the coastal environment. In Fenton, A. and Kisbán, E. *Food in Change: Eating habits from the middle ages to the present day*. Edinburgh, John Donald, 111-121.

Fenton, A. 1986b. *The Shape of the Past 2: Essays in Scottish ethnology*. Edinburgh, John Donald.

Fenton, A. 1992. Shellfish as bait: The interface between domestic and commercial fishing. In Smout, T. C. *Scotland and the Sea*. Edinburgh, John Donald, 137-153.

Fernie, E. 1988. The church of St. Magnus, Egilsay. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 140-162.

Fieller, N. R. S. and Turner, A. 1982. Number estimation in vertebrate samples. *Journal of Archaeological Science*. 9, 49-62.

Fisher, I. 1993. Orphir Church in its south Scandinavian context. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 375-380.

Flannery, K. V. 1967. The vertebrate fauna and hunting patterns. In Byers, D. S. *The Prehistory of the Tehuacan Valley Volume 1*. Austin, University of Texas Press, 132-177.

Flinn, D. 1989. *Travellers in a Bygone Shetland: An anthology*. Edinburgh, Scottish Academic Press.

Fiskerinæringens Landsforening n.d. *Quality Regulations Relating to Fish and Fishery Products*. Oslo, Fiskerinæringens Landsforening.

Fojut, N. 1987. Mains of Murkle (Olrig Parish). *Discovery & Excavation in Scotland*. 1987, 25.

Foley, R. 1981. A model of regional archaeological structure. *Proceedings of the Prehistoric Society*. 47, 1-17.

Foote, P. G. 1965. Some account of the present state of saga-research. *Scandinavica*. 4, 115-126.

Foote, P. 1984a. On the Saga of the Faroe Islanders. In Barnes, M., Bekker-Nielsen, H. and Weber, G. W. *Peter Foote Aurvandilstá Norse Studies*. Odense, Odense University Press, 165-187.

Foote, P. 1984b. The audience and vogue of the Sagas of Icelanders - some talking points. In Barnes, M., Bekker-Nielsen, H. and Weber, G. W. *Peter Foote Aurvandilstá Norse Studies*. Odense, Odense University Press, 47-55.

Foote, P. 1986. Pre-Viking contacts between Orkney and Scandinavia. In Berry, R. J. and Firth, H. N. *The People of Orkney*. Kirkwall, The Orkney Press, 175-186.

Foote, P. 1988. Observations on *Orkneyinga Saga*. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 183-191.

Fraser, I. A. 1979. The Norse element in Sutherland place names. *Scottish Literary Journal.* Supplement no. IX., 17-27.

Fraser, I. A. 1986. Norse and Celtic place-names around the Dornoch Firth. In Baldwin, J. R. *Firthlands of Ross and Sutherland*. Edinburgh, The Scottish Society for Northern Studies, 23-32.

Friðriksson, A. 1994. *Sagas and Popular Antiquarianism in Icelandic Archaeology*. Aldershot, Avebury.

Friedland, K. 1973. Der Hansische Shetlandhandel. In *Stadt und Land in der Geschichte des Ostseeraums*. Lübeck, 66-79. (Translated copy kindly provided by the Shetland Archives).

Friedland, K. 1983. Hanseatic merchants and their trade with Shetland. In Withrington, D. J. *Shetland and the Outside World 1469-1969*. Oxford, Oxford University Press, 86-95.

Futty, D. W. and Towers, W. 1982. *Soil and Land Capability for Agriculture, Northern Scotland*. Aberdeen, The Macaulay Institute for Soil Research.

Gade, J. A. 1951. *The Hanseatic Control of Norwegian Commerce during the Late Middle Ages*. Leiden, E. J. Brill.

Gaimster, D. R. M. 1986. Dung tempering? a Late Norse case study from Caithness. *Medieval Ceramics*. 10, 43-47.

Gaimster, D. R. M. and Batey, C. E. forthcoming. The pottery. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Gaimster, M. 1992. Scandinavian Gold Bracteates in Britain. Money and media in the Dark Ages. *Medieval Archaeology*. 36, 1-28.

Galster, G. 1970. *Anglo-Saxon Coins of Cnut*. London, British Academy.

Garrod, D. J. 1977. The North Atlantic Cod. In Gulland, J. A. *Fish Population Dynamics*. London, John Wiley & Sons, 216-242.

Gautier, A. 1984. How do I count you, let me count the ways? Problems of archaeozoological quantification. In Grigson, A. and Clutton-Brock, J. *Animals and*

Archaeology 4: Husbandry in Europe. Oxford, British Archaeological Reports, International Series 227, 237-251.

Gautier, A. 1987. Taphonomic groups: How and why. *Archaeozoologia*. 1, 47-52.

Gelling, P. S. 1984. The Norse buildings at Skaill, Deerness, Orkney, and their immediate predecessor. In Fenton, A. and Pálsson, H. *The Northern and Western Isles in the Viking World: Survival, continuity and change*. Edinburgh, John Donald, 12-39.

Gelling, P., Brooks, S. and Buteux, S. forthcoming. Medieval and post-medieval buildings. In Buteux, S. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and Later Periods*. 1-20.

Gemmill, E. and Mayhew, N. 1995. *Changinging Prices in Medieval Scotland.* Cambridge, Cambridge University Press.

Gelsinger, B. E. 1981. *Icelandic Enterprise: Commerce and economy in the Middle Ages*. Columbia, University of South Carolina Press.

Gerriets, M. 1985. Money among the Irish: Coin hoards in Viking Age Ireland. *Journal of the Royal Society of Antiquaries of Ireland*. 115, 121-139.

Gidney, L. J. forthcoming. Mammal bone. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Gifford, J. 1992. *The Buildings of Scotland: Highlands and Islands*. London, Penguin Books in association with The Buildings of Scotland Trust.

Gilbert, A. S. and Singer, B. H. 1982. Reassessing zooarchaeological quantification. *World Archaeology*. 14, 21-40.

Gilbert, J. M. 1979. *Hunting and Hunting Reserves in Medieval Scotland*. Edinburgh, John Donald.

Gillen, C. 1986. Geology and landscape of Easter Ross and Sutherland. In Baldwin, J. R. *Firthlands of Ross and Sutherland.* Edinburgh, The Scottish Society for Northern Studies, 1-22.

Gills, B. K. and Frank, A. G. 1993. World system cycles, crises, and hegemonic shifts, 1700 BC to 1700 AD. In Frank, A. G. and Gills, B. K. *The World System: Five hundred years or five thousand*. London, Routledge, 143-199.

Goodlad, C. A. 1971. *Shetland Fishing Saga*. Lerwick, Shetland Times.

Goudie, G. 1904. *The Celtic and Scandinavian Antiquities of Shetland.* Edinburgh, William Blackwood and Sons.

Gould, S. J. 1966. Allometry and size in ontogeny and phylogeny. *Biological Review of the Cambridge Philosophical Society*. 41, 587-640.

Graham-Campbell, J. 1976. The Viking-age silver and gold hoards of Scandinavian character from Scotland. *Proceedings of the Society of Antiquaries of Scotland*. 107, 114-135.

Graham-Campbell, J. 1980. *Viking Artefacts: A select catalogue*. London, British Museum Publications Limited.

Graham-Campbell, J. 1983a. The Viking-age silver hoards of the Isle of Man. In Fell, C., Foote, P., Graham-Campbell, J. and Thomson, R. *The Viking Age in the Isle of Man*. London, Viking Society for Northern Research, 53-80.

Graham-Campbell, J. 1983b. Some Viking-Age penannular brooches from Scotland and the origins of the 'thistle-brooch'. In O'Connor, A. and Clarke, D. V. *From the Stone Age to the 'Forty Five: Studies presented to R.B.K. Stevenson*. Edinburgh, John Donald, 310-323.

Graham-Campbell, J. 1984. Two Viking-Age silver brooch fragments believed to be from the 1858 Skaill (Orkney) hoard. *Proceedings of the Society of Antiquaries of Scotland*. 114, 289-301.

Graham-Campbell, J. 1985. A lost Pictish treasure (and two Viking-Age gold arm-rings) from the Broch of Burgar, Orkney. *Proceedings of the Society of Antiquaries of Scotland*. 115, 241-261.

Graham-Campbell, J. 1989. *The Viking World*. Leicester, Windward.

Graham-Campbell, J. A. 1993. The northern hoards of Viking-Age Scotland. In Batey, C. E., Jesch, J. and Morris, C. D. *The Viking Age in Caithness, Orkney and the North Atlantic*. Edinburgh, Edinburgh University Press, 173-186.

Graham-Campbell, J. A. 1995. *The Viking-Age Gold and Silver of Scotland*. Edinburgh, National Museums of Scotland.

Grahame, T. 1968. Animal bones. In Hamilton, J. R. C. *Excavations at Clickhimin, Shetland*. Edinburgh, HMSO, 166-167.

Grant, F. J. 1902. *The Commissariot Record of Caithness. Register of Testaments 1661-1664*. Edinburgh, Scottish Record Society.

Gray, M. 1978. *The Fishing Industries of Scotland 1790-1914*. Oxford, Oxford University Press.

Grayson, D. K. 1984. *Quantitative Zooarchaeology*. London, Academic Press.

Grayson, D. K. 1989. Bone transport, bone destruction, and reverse utility curves. *Journal of Archaeological Science*. 16, 643-652.

Greenfield, H. J. 1988. Bone consumption by pigs in a contemporary Serbian village: Implications for the interpretation of prehistoric faunal assemblages. *Journal of Field Archaeology*. 15, 473-479.

Greenfield, H. J. 1991. Fauna from the Late Neolithic of the central Balkans: Issues in subsistence and land use. *Journal of Field Archaeology*. 18, 161-186.

Grieg, S. 1940. *Viking Antiquities in Scotland, Viking Antiquities in Great Britain and Ireland Part II*. Oslo, H. Aschehoug & Co.

Grierson, P. 1959. Commerce in the Dark Ages: A critique of the evidence. *Transactions of the Royal Historical Society*. Fifth Series 9, 123-140.

Griffin, K. 1994. The usage of wild berries and other fruits in the Mediaeval and Post-mediaeval households in Norway. *Botanical Journal of Scotland*. 46, 521-526.

Grove, J. 1988. *The Little Ice Age*. London, Routledge.

Gunnes, E. and Kjellberg, H. 1979. *Regesta Norvegica IV 1320-1336*. Oslo, Norsk Historisk Kjeldeskrift Institutt.

Guðmundsson, F. 1965. *Islenzk Fornrit XXXIV Bindi, Orkneyinga Saga*. Reykjavík, Hið Islenzka Fornritafélag.

Guðmundsson, F. 1993. On the writing of *Orkneyinga Saga*. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 204-211.

Hagen, A. 1993. *A Handbook of Anglo-Saxon Food: Processing and consumption*. Pinner, Middlesex, Anglo-Saxon Books.

Hamilton, J. R. C. 1956. *Excavations at Jarlshof*. Edinburgh, HMSO.

Hamilton-Dyer, S. 1991. Tuquoy, Westray, Orkney: Bird bones. Unpublished report submitted to O. Owen, Historic Scotland.

Hamilton-Dyer, S. forthcoming. Bird bone. In Lowe, C. *Excavations at St. Boniface, Papa Westray, Orkney*.

Hammond, P. W. 1993. *Food and Feast in Medieval England*. Dover, Alan Sutton Publishing Limited.

Hårdh, B. 1978. Trade and Money in Scandinavia in the Viking Age. *Meddelanden från Lunds Universitets Historiska Museum*. 1977-1978, 157-171.

Harkness, D. D. 1981. The extent of natural ^{14}C deficiency in the coastal environment of the United Kingdom. In Mook, W. G. *Proceedings: 1st International Symposium on C-14 and Archaeology*. Groningen.

Harkonen, T. 1986. *Guide to the Otoliths of the Boney Fishes of the Northeast Atlantic*. Denmark, Danbui ApS.

Hastrup, K. 1985. *Culture and History in Medieval Iceland: An anthropological analysis of structure and change*. Oxford, Oxford University Press.

Hedeager, L. 1992. *Iron-Age Societies: From Tribe to State in Northern Europe 500 BC to AD 700*. Oxford, Blackwell.

Hedeager, L. 1994. Warrior economy and trading economy in Viking-Age Scandinavia. *Journal of European Archaeology*. 2, 130-147.

Hedges, J. W. 1978. A long cist at Sandside, Graemsay, Orkney. *Proceedings of the Society of Antiquaries of Scotland*. 109, 374-378.

Hedges, J. W. 1983. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 10, 73-124.

Hedges, J. W. 1987. *Bu, Gurness and the Brochs of Orkney Part 2: Gurness*. Oxford, British Archaeological Reports British Series 164.

Hedges, R. E. M. and Millard, A. R. 1995. Bones and groundwater: Towards the modelling of diagenetic processes. *Journal of Archaeological Science*. 22, 155-164.

Heinrich, D. 1983. Temporal changes in fishery and fish consumption between early medieval Haithabu and its successor, Schleswig. In Grigson, C. and Clutton-Brock, J. *Animals and Archaeology 2. Shell Middens, Fishes and Birds*. Oxford, British Archaeological Reports International Series 183, 151-156.

Heinrich, D. 1986a. Fishing and consumption of cod (*Gadus morhua* Linnaeus, 1758) in the Middle Ages. In Brinkhuizen, D. C. and Clason, A. T. *Fish and Archaeology*. Oxford, British Archaeological Reports, 42-52.

Heinrich, D. 1986b. Fang und konsum von kabeljau im mittelalter. *Offa*. 43, 87-93.

Heinrich, D. 1987. Familie Dorschfische, Gadidae. In *Ausgrabungen in Schleswig*. Neumünster, Berichte und Studien 6, 87-126.

Heinrich, D. 1994. Fish remains of two medieval castles and of an urban context - a comparison. In Van Neer, W. *Fish Exploitation in the Past: Proceedings of the 7th meeting of the ICAZ fish remains working group*. Tervuren, Musee Royal de L'Afrique Centrale, 211-216.

Heinrich, D. in press. Untersuchungen an Fischresten aus Kloaken des 17. Jahrhunderts in Höxter sowie Bemerkungen zu den dort geborgenen Knochen von Froschlurchen. *Ausgrabungen und Funde in Westfalen-Lippe*. 9.

Helle, K. 1988. The organisation of the twelfth-century church in Norway. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 46-55.

Helle, K. 1993. Norway, 800-1200. In Faulkes, A. and Perkins, R. *Viking Revaluations*. London, Viking Society for Northern Research, 1-14.

Henderson, T. 1978. Shetland boats and their origins. In Baldwin, J. R. *Scandinavian Shetland, An Ongoing Tradition*? Edinburgh, Scottish Society for Northern Studies, 49-55.

Henderson, T. 1985. Shipwreck and Underwater Archaeology in Shetland. In Smith, B. *Shetland archaeology: new work in the 1970s*. Lerwick, The Shetland Times Ltd., 175-212.

Herteig, A. E. 1985. The archaeological excavations at Bryggen, "The German Wharf", in Bergen, 1955-68. In Herteig, A., Hagen, A. and Helle, K. *The Bryggen Papers, Main Series Volume 1*. Bergen, Universitetsforlaget AS, 9-46.

Hesse, B. H. and Wapnish, P. 1985. *Animal Bone Archaeology*. Washington, Taraxacum.

Hibberd, H. forthcoming. Amphibians and small mammals. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Hibbert, S. 1822. *A Description of the Shetland Islands*. Edinburgh, Archibald Constable & Co.

Hight, G. A. and Foote, P. 1965. *The Saga of Grettir the Strong*. London, Everyman's Library.

Hillman, G. C. 1984. Interpretation of archaeological plant remains: The application of ethnographic models from Turkey. In Van Zeist, W. and Casparie, W. A. *Plants and Ancient Man: Studies in palaeoethnobotany*. Rotterdam, A.A. Balkema, 1-41.

Hinton, P. 1990. Weed associates of recently grown *Avena strigosa* Schreber from Shetland, Scotland. *Circaea*. 49-54.

Hodges, R. 1978. Ports of trade in early medieval Europe. *Norwegian Archaeological Review*. 11.

Hodges, R. 1988. *Primitive and Peasant Markets*. Oxford, Basil Blackwell.

Hodges, R. 1989a. *Dark Age Economics: The origins of towns and trade AD 600-1000*. London, Duckworth.

Hodges, R. 1989b. *The Anglo-Saxon Achievement*. London, Duckworth.

Hoffecker, J. F., Baryshnikov, G. and Potapova, O. 1991. Vertebrate remains from the Mousterian site of Il'skaya I (Northern Caucasus, U.S.S.R.): New analysis and interpretation. *Journal of Archaeological Science*. 18, 113-147.

Hörandner, E. 1986. Storing and preserving meat in Europe: Historical survey. In Fenton, A. and Kisbán, E. *Food in Change: Eating habits from the middle ages to the present day*. Edinburgh, John Donald, 53-59.

Hufthammer, A. K. 1994. The dog bones from Bryggen. In Herteig, A. E., Helle, K. and Indrelid, S. *The Bryggen Papers Supplementary Series No 5*. Bergen, Scandinavian University Press, 209-285.

Huggett, J. W. 1988. Imported grave goods and the early Anglo-Saxon economy. *Medieval Archaeology*. 32, 63-96.

Hughes, M. K. and Diaz, H. F. 1994. Was there a 'Medieval Warm Period', and if so, where and when. *Climatic Change*. 26, 109-142.

Hunter, J. R. 1986. *Rescue Excavations on the Brough of Birsay 1974-82*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 4.

Hunter, J. R., Bond, J. M., Chudecka, A., Cotton, S. E., MacSween, A. and Smith, A. N. 1990. Pool, Sanday: A case study for the Late Iron Age and Viking periods. In Armit, I. *Beyond the Brochs*. Edinburgh, 175-193.

Hunter, J. R., Bond, J. M. and Smith, A. M. 1993. Some aspects of Viking settlement in Orkney. In Batey, C. E., Jesch, J. and Morris, C. D. *The Viking Age in Caithness, Orkney and the North Atlantic*. Edinburgh, Edinburgh University Press, 272-284.

Hunter, J. and Morris, C. D. 1981. Recent excavations at the Brough of Birsay, Orkney. In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 245-258.

Hunter, J. R. and Morris, C. D. 1982. Excavation of Room 5 clifftop settlement Brough of Birsay 1973-4. In Curle, C. L. *Pictish and Norse Finds from the Brough of Birsay 1934-74*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 1, 124-138.

Huntley, J. P. 1990. Earl's Bu, Orphir, Orkney: Interim report upon carbonised plant remains from EB79/80. Unpublished report.

Huntley, J. P. 1994. Some botanical aspects of a Norse economy in northern Scotland. *Botanical Journal of Scotland*. 46, 538-541.

Huntley, J. P. forthcoming. Pollen analytical investigations. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Huntley, J. P. and Turner, J. forthcoming. Carbonised plant remains. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links*

Caithness: Excavation and survey of a Norse settlement. Inverness, Highland Regional Council Monograph No. 1.

Hydrographic Office 1993a. *Admiralty Chart 219 Western Approaches to the Orkney and Shetland Islands.* Taunton, Hydrographic Office Admiralty Charts and Publications.

Hydrographic Office 1993b. *Admiralty Chart SC2635 Scotland West Coast.* Taunton, Hydrographic Office Admiralty Charts and Publications.

Hydrographic Office 1993c. *Admiralty Chart 2182C North Sea - Northern Sheet.* Taunton, Hydrographic Office Admiralty Charts and Publications.

Hydrographic Office 1993d. *Admiralty Chart 1785 North Minch - Northern Part.* Taunton, Hydrographic Office Admiralty Charts and Publications.

Ijzereef, G. F. and Laarman, F. 1986. The Animal Remains from Deventer (8th-19th Centuries AD). *Proceedings of the State Service for Archaeological Investigations in the Netherlands.* 1986, 405-443.

Ingimundarson, J. H. 1992. Spinning goods and tales: Market, subsistence and literary productions. In Pálsson, G. *From Sagas to Society: Comparative approaches to early Iceland.* Enfield Lock, Hisarlik Press, 217-230.

Irvine, J. J. A. and Morrison, I. A. 1987. Shetlanders and fishing: Historical and geographical aspects of an evolving relationship. *Northern Studies.* 24, 43-56.

Johnston, G. 1994. *Thrand of Gotu: Two Icelandic sagas from the Flat Island Book.* Erin, Ontario, The Porcupine's Quill, Inc.

Innis, H. A. 1940. *The Cod Fisheries.* Toronto, University of Toronto Press.

Irving, B. 1994. Seasonality in the Atlantic Salmon *Salmo salar*, exploring the resource scheduling "Myth". Paper presented at Association for Environmental Archaeology 1994 Annual Conference, Zwartsluis.

Jackson, H. E. 1989. The trouble with transformations: Effects of sample size and sample composition on weight estimates based on skeletal mass allometry. *Journal of Archaeological Science.* 16, 601-610.

Jankuhn, H. 1982. Trade and settlement in central and northern Europe up to and during the Viking period. *Journal of the Royal Society of Antiquaries of Ireland.* 112, 18-50.

Jesch, J. 1993. England and *Orkneyinga Saga.* In Batey, C. E., Jesch, J. and Morris, C. D. *The Viking Age in Caithness, Orkney and the North Atlantic.* Edinburgh, Edinburgh University Press, 222-239.

Johnston, A. W. and Johnston, A. 1907-1913. *Diplomatarium Orcadense et Hialtlandense: Orkney and Shetland Records Volume I.* London, Viking Society for Northern Research.

Johnston, A. W. and Johnston, A. 1907-1942. *Diplomatarium Orcadense et Hialtlandense: Orkney and Shetland Records Volume II.* London, Viking Society for Northern Research.

Johnston, A. W. and Johnston, A. 1908-1942. *Diplomatarium Orcadense et Hialtlandense: Orkney and Shetland Records Volume III.* London, Viking Society for Northern Research.

Johnston, A. W. and Johnston, A. 1909-1928. *Diplomatarium Katanense et Sutherlandense: Caithness and Sutherland Records*. London, Viking Society for Northern Research Old-Lore Series 10.

Jones, A. 1995. Was pottery produced at Robert's Haven? Unpublished report.

Jones, A. K. G. 1982. Bulk-sieving and the recovery of fish remains from urban archaeological sites. In Hall, A. R. and Kenward, H. *Environmental Archaeology in the Urban Context*. London, Council for British Archaeology Research Report 43, 79-85.

Jones, A. K. G. 1984. Some effects of the mammalian digestive system on fish bones. In Desse-Berset, N. *Second Fish Osteoarchaeology Meeting*. Paris, Centre National de la Recherches Archeologiques, Notes et Monographies Techniques 16, 61-65.

Jones, A. K. G. 1986. Fish bone survival in the digestive systems of the pig, dog and man: Some experiments. In Brinkhuizen, D. C. and Clason, A. T. *Fish and archaeology*. Oxford, British Archaeological Reports, 53-61.

Jones, A. K. G. 1990. Experiments with fish bones and otoliths: Implications for the reconstruction of past diet and economy. In Robinson, D. E. *Experimentation and reconstruction in environmental archaeology*. Oxford, Oxbow Books, 143-146.

Jones, A. K. G. 1991a. The fish remains from excavations at Freswick Links, Caithness. D.Phil, University of York.

Jones, A. K. G. 1991b. Preliminary observations on fish remains from a late Norse settlement in Caithness. *Acta Archaeologica*. 61, 220-227.

Jones, A. K. G. 1992. Fish. In Lightfoot, K. W. B. Rumney Castle, a ringwork and manorial centre in south Glamorgan. *Medieval Archaeology*. 36, 154.

Jones, A. K. G., Batey, C. E., Morris, C. D. and Rackham, D. J. 1983. Man and the environment at Freswick Links: Preliminary observations from a Late Norse settlement in Caithness. In Jones, M. *Integrating the subsistence economy*. Oxford, British Archaeological Reports, 163-176.

Jones, A. K. G., Morris, C. D. and Rackham, D. J. forthcoming a. Environmental sampling: Methods and materials. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Jones, A. K. G., Morris, C. D. and Rackham, D. J. forthcoming b. The fish remains. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Jones, G. 1984. *A History of the Vikings*. Oxford, Oxford University Press.

Jones, G. 1986. *The Norse Atlantic Saga*. Oxford, Oxford University Press.

Jones, J. n.d. Waterlogged plant remains from the Norse and Medieval settlement of Tuquoy, Orkney. Unpublished report submitted to O. Owen, Historic Scotland.

Jowsey, P. C. 1973. Peatlands. In Tivy, J. *The Organic Resources of Scotland*. Edinburgh, Oliver & Boyd, 109-121.

Kaland, S. H. H. 1973. Westnessutgravningene På Rousay, Orknøyene. *Viking*. 37, 77-102.

Kaland, S. H. H. 1980. Excavations 1980 at Westness, Rousay, Orkney. Unpublished report submitted to Historic Scotland.

Kaland, S. H. H. 1982. Some economic aspects of the Orkneys in the Viking period. *Norwegian Archaeological Review*. 15, 85-95.

Kaland, S. H. H. 1987. Viking/medieval settlement in the heathland area of Nordhordland. In Knirk, J. E. *Proceedings of the Tenth Viking Congress*. Oslo, Universitetets Oldsaksamling, 171-190.

Kaland, S. H. H. 1993. The settlement of Westness, Rousay. In Batey, C. E., Jesch, J. and Morris, C. D. *The Viking Age in Caithness, Orkney and the North Atlantic*. Edinburgh, Edinburgh University Press, 308-317.

Karras, R. M. 1988. *Slavery & Society in Medieval Scandinavia*. London, Yale University Press.

Keller, C. 1991. Vikings in the west Atlantic: A model of Norse Greenlandic medieval society. *Acta Archaeologica*. 61, 126-141.

Kenny, M. 1987. The geographical distribution of Irish Viking-Age coin hoards. *Proceedings of the Royal Irish Academy*. 87, 507-525.

Kent, S. 1981. The dog: An archaeologist's best friend or worst enemy - The spatial distribution of faunal remains. *Journal of Field Archaeology*. 8, 367-372.

Kent, S. 1984. *Analyzing Activity Areas*. Albuquerque.

McNiven, I. J. 1992. Shell middens and mobility: The use of off-site faunal remains, Queensland, Australia. *Journal of Field Archaeology*. 19, 495-508.

Keyser, R. and Munch, P. A. 1848. *Norges Gamle Love Indtil 1382. Andet Bind.* Christiania(Oslo), Gröndahl.

Klein, R. G. and Cruz-Uribe, K. 1984. *The Analysis of Animal Bones from Archaeological Sites*. Chicago, University of Chicago Press.

Knowlton, D. 1974. *The Naturalist in Scotland*. London, David & Charles.

Kreutzer, L. A. 1992. Bison and deer bone mineral densities: Comparisons and implications for the interpretation of archaeological faunas. *Journal of Archaeological Science*. 19, 271-294.

Kruse, S. E. 1988. Ingots and weight units in Viking Age silver hoards. *World Archaeology*. 20, 285-301.

Kruse, S. E. 1993. Silver storage and circulation in Viking-Age Scotland: The evidence of silver ingots. In Batey, C. E., Jesch, J. and Morris, C. D. *The Viking Age in Caithness, Orkney and the North Atlantic*. Edinburgh, Edinburgh University Press, 187-203.

Kruse, S. E. and Tate, J. 1992. XRF analysis of Viking Age silver ingots. *Proceedings of the Society of Antiquaries of Scotland*. 122, 295-328.

Kubasiewicz, M. 1956. O metodyce badan wykopaliskowych szczatkow kostnych zwierzecych. *Materialy Zachodnio-Pomorskie*. 2, 235-244.

Laing, S. 1889. *The Heimskringla, Volume 1*. London, John C. Nimmo.

Lamb, H. 1991. *Historic Storms of the North Sea, British Isles and Northwest Europe.* Cambridge, Cambridge University Press.

Lamb, R. G. 1974. Coastal settlements of the north. *Scottish Archaeological Forum.* 5, 76-103.

Lamb, R. G. 1980a. *Iron Age Promontory Forts in the Northern Isles.* Oxford, British Archaeological Reports British Series 79.

Lamb, R. G. 1980b. *The Archaeological Sites and Monuments of Sanday and North Ronaldsay, Orkney.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. G. 1982. *The Archaeological Sites and Monuments of Rousay, Egilsay and Wyre (with adjacent small islands), Orkney Islands Area.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. G. 1983a. *The Archaeological Sites and Monuments of Papa Westray and Westray, Orkney Islands Area.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. G. 1983b. The cathedral and the monastery. *Orkney Heritage.* 2, 36-45.

Lamb, R. G. 1984. *The Archaeological Sites and Monuments of Eday and Stronsay, Orkney Islands Area.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. G. 1987. *The Archaeological Sites and Monuments of Shapinsay, St Andrews and Deerness (with adjacent small islands), Orkney Islands Area.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. G. 1989. *The Archaeological Sites and Monuments of Hoy and Waas, Orkney Islands Area.* Edinburgh, Royal Commission on the Ancient and Historical Monuments of Scotland.

Lamb, R. 1993a. Kirkwall. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age.* Edinburgh, Edinburgh University Press, 44-49.

Lamb, R. 1993b. The Wirk, Rousay. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age.* Edinburgh, Edinburgh University Press, 53-54.

Lamb, R. 1993c. Carolingian Orkney and its transformation. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age.* Edinburgh, Edinburgh University Press, 260-271.

Lange, C. C. A. and Unger, C. R. 1849-1919. *Diplomatarium Norvegicum.* Christiania (Oslo), Mallingske Bogtrykkeri.

Larson, L. M. 1935. *The Earliest Norwegian Laws being the Gulathing Law and the Frostathing Law.* New York, Columbia University Press.

Leach, B. F. 1986. A method for the analysis of Pacific Island fishbone assemblages and an associated database management system. *Journal of Archaeological Science.* 13, 147-159.

Leask, W. 1993. Interview. Lerwick, Shetland.

Lee, R. B. 1990. Primitive communism and the origin of social inequality. In Upham, S. *The Evolution of Political Systems*. Cambridge, Cambridge University Press, 225-246.

Lee, A. J. and Ramster, J. W. 1981. *Atlas of the Seas around the British Isles*. Southampton, Ministry of Agriculture, Fisheries and Food.

Legge, A. J. 1981. The agricultural economy. In Mercer, R. J. *Grimes Graves, Norfolk: Excavations 1971-2, Volume 1*. London, Department of the Environment: Archaeological Report 11, 79-103.

Lie, R. W. 1980. Minimum number of individuals from osteological samples. *Norwegian Archaeological Review*. 13, 24-30.

Liestøl, A. 1984. Runes. In Fenton, A. and Pálsson, H. *The Northern and Western Isles in the Viking World*. Edinburgh, 224-238.

Lindkvist, T. 1993. Feudal influences and tendencies. In Pulsiano, P. *Medieval Scandinavia*. London, Garland Publishing, Inc., 187-188.

Linse, A. R. 1992. Is bone safe in a shell midden? In Stein, J. K. *Deciphering a Shell Midden*. London, Academic Press, 327-345.

Llanerch Press 1991. Publisher's preface. In Stevenson, J. *A Medieval Chronical of Scotland, The Chronicle of Melrose*. Lampeter, Llanerch Press, 5.

Long, C. D. 1975. Excavations in the medieval city of Trondheim, Norway. *Medieval Archaeology*. 14, 1-32.

Lorimer, D. H. n.d. Upper Scalloway: The human remains. Unpublished report for Historic Scotland.

Low, G. 1813. *Fauna Orcadensis or The Natural History of the Quadrupeds, Birds, Reptiles, and Fishes of Orkney and Shetland*. Edinburgh, George Ramsay and Company.

Low, G. 1879 [1774]. *A Tour Through the Islands of Orkney and Shetland Containing Hints Relative to their Ancient Modern and Natural History Collected in 1774*. Kirkwall, William Peace & Son.

Lowe, C. E. 1990. St. Boniface Church (Papa Westray parish). *Discovery & Excavation in Scotland*. 45-46.

Lowe, C. E. 1993. Preliminary results of the excavation assessment at Munkerhoose cliff-section and farm mound, St Boniface Church, Papa Westray, Orkney. *Northern Studies*. 30, 19-33.

Lund, N. 1981. The settlers: Where do we get them from - and do we need them? In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 147-171.

Lund, N. 1984. *Two Voyagers at the Court of King Alfred*. York, William Sessions Limited.

Lunt, D. A. and Young, A. 1989. Excavations beside the Brough Road: Human skeletal material. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 273-277.

Lyman, R. L. 1979. Available meat from faunal remains: A consideration of techniques. *American Antiquity*. 44, 536-546.

Lyman, R. L. 1984. Bone density and differential survivorship of fossil classes. *Journal of Anthropological Archaeology*. 3, 259-299.

Lyman, R. L. 1989. Seal and sea lion hunting: A zooarchaeological study from the southern Northwest Coast of North America. *Journal of Anthropological Archaeology*. 8, 68-99.

Lyman, R. L. 1994. *Vertebrate Taphonomy*. Cambridge, Cambridge University Press.

Lynam, E. 1936. Early maps of Scandinavia and Iceland. *Saga-Book*. 11, 1-4.

Lyon, P. J. 1970. Differential bone destruction: An ethnographic example. *American Antiquity*. 35, 213-215.

MacAirt, S. and MacNiocaill, G. 1983. *The Annals of Ulster (to A.D. 1131)*. Dublin, Dublin Institute for Advanced Studies.

MacAskill, N. 1982. The Pottery. In McGavin, N. A. Excavations in Kirkwall, 1978. *Proceedings of the Society of Antiquaries of Scotland*. 108, 392-436.

Macaulay, D. 1982. Place names. In Omand, D. *The Sutherland Book*. Golspie, The Northern Times Limited, 278-292.

Macaulay Institute for Soil Research 1982a. *Northern Scotland Sheet 3 (Soil)*. Southampton, Ordnance Survey.

Macaulay Institute for Soil Research 1982b. *Orkney and Shetland Sheet 1 (Soil)*. Southampton, Ordnance Survey.

Macaulay Institute for Soil Research 1983a. *Northern Scotland Sheet 3 (Land Capability for Agriculture)*. Southampton, Ordnance Survey.

Macaulay Institute for Soil Research 1983b. *Orkney and Shetland Sheet 1 (Land Capability for Agriculture)*. Southampton, Ordnance Survey.

MacDonald, D. and Barrett, P. 1993. *Mammals of Britain and Europe*. London, Harper Collins Publishers.

MacGibbon, D. and Ross, T. 1990 [1887-1892]. *The Castellated and Domestic Architecture of Scotland from the Twelfth to the Eighteenth Century*. Edinburgh, The Mercat Press.

MacGibbon, D. and Ross, T. 1991 [1896-1897]. *The Ecclesiastical Architecture of Scotland, from the Earliest Christian Times to the Seventeenth Century*. Edinburgh, Mercat Press.

MacGregor, A. 1982. Anglo-Scandinavian finds from Lloyds Bank, Pavement, and other sites. *The Archaeology of York*. 17/3, 67-174.

MacGregor, L. J. 1984. Sources for a study of Norse settlement in Shetland and Faroe. In Crawford, B. E. *Essays in Shetland History*. Lerwick, The Shetland Times Ltd., 1-17.

MacQueen, H. L. 1990. Scots law under Alexander III. In Reid, N. *Scotland in the Reign of Alexander III*. Edinburgh, John Donald, 74-102.

Magnus, B. 1974. Fisker eller bonde? Undersøkelser av hustufter på ytterkysten. *Viking*. 68-108.

Magnusson, M. and Pálsson, H. 1960. *Njal's Saga*. London, Penguin.

Magnusson, M. and Pálsson, H. 1966. *King Harald's Saga*. London, Penguin.

Magnus, O. 1555. *Historia de Gentibus Septentrionalibus*. Rome.

Mahler, D. L. D. 1991. Argisbrekka: New evidence of shielings in the Faroe Islands. *Acta Archaeologica*. 61, 60-72.

Mainland, I. 1993. The animal bone assemblage from the 1988 excavations at the Earl's Bu, Orphir, Orkney. Sheffield Environmental Facility unpublished report.

Mainland, I. 1994. A preliminary discussion of the animal bone assemblage from the 1989 excavations at the Earl's Bu (EB89), Orphir, Orkney. Sheffield Environmental Facility unpublished report.

Mainland, I. n.d. A preliminary discussion of the animal bone from the1979-1980 and 1985-1986 excavations at the Earl's Bu, Orphir, Orkney. Unpublished report.

Maitland, P. S. and Campbell, R. N. 1992. *Freshwater Fishes of the British Isles*. London, Harper Collins Publishers.

Mann, M. 1986. *The Sources of Social Power Volume 1*. Cambridge, Cambridge University Press.

Marcus, G. W. 1980. *The Conquest of the North Atlantic*. Woodbridge, The Boydell Press.

Marean, C. W. 1991. Measuring the post-depositional destruction of bone in archaeological assemblages. *Journal of Archaeological Science*. 18, 677-694.

Marshall, F. and Pilgram, T. 1991. Meat versus within-bone nutrients: Another look at the meaning of body part representation in archaeological sites. *Journal of Archaeological Science*. 18, 149-163.

Martin, M. 1981[1716]. *A Description of the Western Islands of Scotland*. Edinburgh, James Thin.

Marwick, H. 1952. *Orkney Farm-Names*. Kirkwall, W.R. Mackintosh.

Marwick, H. 1970. *The Place-Names of Birsay*. Aberdeen, Aberdeen University Press.

Matheson, W. 1817. *Map or Plan of the Lands of Duncansbay*. Edinburgh, Scottish Record Office Reference RHP 75/3.

Mayhew, N. J. 1989. The Aberdeen, St. Nicholas Street, hoards of 1983 and 1984. *The British Numismatic Journal*. 58, 40-68.

McCormick, F. 1992. Early faunal evidence for dairying. *Oxford Journal of Archaeology*. 11, 201-209.

McCormick, F. forthcoming. Mammal bone. In Lowe, C. E. *Excavations at St. Boniface, Papa Westray, Orkney*.

McCullagh, R. 1982. The Wood. In McGavin, N. A. Excavations in Kirkwall, 1978. *Proceedings of the Society of Antiquaries of Scotland*. 392-436.

McDonnell, G. 1986a. Iron and Iron Working. In Hunter, J. R. *Rescue Excavations on the Brough of Birsay 1974-82*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 4, 198-203.

McDonnell, J. G. 1986b. Industrial residue. In Morris, C. D. and Emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 338-339.

McGavin, N. A. 1982. Excavations in Kirkwall, 1978. *Proceedings of the Society of Antiquaries of Scotland*. 112, 392-436.

McGovern, T. H. 1980. Cows, harp seals, and churchbells: Adaptation and extinction in Norse Greenland. *Human Ecology*. 8, 245-275.

McGovern, T. H. 1985. Contributions to the paleoeconomy of Norse Greenland. *Acta Archaeologica*. 54, 73-122.

McGovern, T. H. 1990. The archaeology of the Norse North Atlantic. *Annual Review of Anthropology*. 19, 331-351.

McGovern, T. H. 1992. Bones, buildings, and boundaries: Palaeoeconomic approaches to Norse Greenland. In Morris, C. D. and Rackham, D. J. *Norse and Later Settlement and Subsistence in the North Atlantic*. Glasgow, University of Glasgow Department of Archaeology, 193-230.

McGovern, T. H. 1994. Management for extinction in Norse Greenland. In Crumley, C. *Historical Ecology: Cultural knowledge and changing landscapes*. Santa Fe, New Mexico, School of American Research Press, 127-154.

McGovern, T. H. forthcoming. Rooms and refuse in Norse Greenland: Some patterns of accumulation.

McGovern, T. H., Bigelow, G., Amorosi, T. and Russell, D. 1988. Northern islands, human error, and environmental degradation: A view of social and ecological change in the medieval North Atlantic. *Human Ecology*. 16, 225-270.

McGregor, A. 1880. Notes on some Old Customs in the Island of Sky. *Proceedings of the Society of Antiquaries of Scotland*. 14, 143-148.

McGrew, J.. 1970. *Sturlunga Saga, Volume 1*. New York, American-Scandinavian Foundation.

McGrew, J. and Thomas, R. G. 1974. *Sturlunga Saga, Volume* 2. New York, American-Scandinavian Foundation.

McNeill, G. P. 1901. *The Exchequer Rolls of Scotland Volume XXI A.D. 1580-1588*. Edinburgh, H.M. General Register House.

McNiven, I. J. 1992. Shell middens and mobility: The use of off-site faunal remains, Queensland, Australia. *Journal of Field Archaeology*. 19, 495-508.

Mellars, P. A. and Wilkinson, M. R. 1980. Fish otoliths as indicators of seasonality in prehistoric shell middens: The evidence from Oronsay (Inner Hebrides). *Proceedings of the Prehistoric Society*. 46, 19-44.

Metcalf, D. M. 1977. The evidence of Scottish coin hoards for monetary history, 1100-1600. In Metcalf, D. M. *Coinage in Medieval Scotland*. Oxford, British Archaeological Reports British Series 45, 1-59.

Miller, J. 1989a. From reformation to improvement. In Omand, D. *The New Caithness Book*. Wick, North of Scotland Newspapers, 91-103.

Miller, J. 1989b. Modern times. In Omand, D. *The New Caithness Book*. Wick, North of Scotland Newspapers, 104-117.

Miller, W. I. 1986. Gift, sale, payment, raid: Case studies in the negotiation and classification of exchange in medieval Iceland. *Speculum*. 61, 18-50.

Miller, W. I. 1990. *Bloodtaking and Peacemaking*. Chicago, Chicago University Press.

Mills, S. A. 1984. Pottery. In Batey, C. E., Morris, C. D. and Rackham, D. J. Freswick Castle, Caithness: Report on rescue excavations carried out in 1979. *Glasgow Archaeological Journal*. 11, 83-118.

Minitab Inc. 1991. Minitab Reference Manual Release 8 Macintosh Version. State College, PA., Minitab Inc.

Mitchell, A. 1906. *Macfarlane's Geographical Collections Volume 1*. Edinburgh, Scottish History Society.

Mitchell, A. 1908. *Macfarlane's Geographical Collections Volume 3*. Edinburgh, Scottish History Society.

Mitchell, D. 1990. Coast Salish subsistence and a methodological barrier. *Northwest Anthropological Research Notes*. 24, 239-247.

Mitchell, S. A. 1993. Óðinn. In Pulsiano, P. *Medieval Scandinavia*. London, Garland Publishing, Inc., 444-445.

Moffat, D. and Buttler, S. J. 1986. Rare earth element distribution patterns in Shetland steatite - consequences for artifact provenancing studies. *Archaeometry*. 101-115, 101-115.

Morales, A., Morales, D. C. and Roselló, E. 1991 Sobre la presencia del bacalao (Gadus morhua) en la Cartuja Sevillana de Santa Mareia de las Cuevas (siglos xv-xvi). *Archivo Hispalense*. 226, 17-24.

Moran, N. C. and O'Connor, T. P. 1994. Age attribution in domestic sheep by skeletal and dental maturation: A pilot study of available sources. *International Journal of Osteoarchaeology*. 4, 267-286.

Morlan, R. E. 1994. Bison bone fragmentation and survivorship: A comparative method. *Journal of Archaeological Science*. 21, 797-808.

Morris, C. D. 1979. The Vikings and Irish monasteries. *Durham University Journal*. 71, 175-185.

Morris, C. D. 1982. The Vikings in the British Isles: Some aspects of their settlement and economy. In Farrell, R. T. *The Vikings*. London, Phillimore & Co., 70-94.

Morris, C. D. 1985. Viking Orkney: A survey. In Renfrew, C. *The Prehistory of Orkney*. Edinburgh, Edinburgh University Press, 210-242.

Morris, C. D. 1989. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1.

Morris, C. D. 1990. *Church and Monastery in the Far North: An archaeological evaluation*. Jarrow, Jarrow Lecture 1989.

Morris, C. D. 1991. Native and Norse in Orkney and Shetland. In Karkov, C. and Farrell, R. *Studies in Insular Art and Archaeology,*. Miami, Miami University School of Fine Arts, American Early Medieval Studies 1, 61-80.

Morris, C. D. 1992. Viking and Late Norse Orkney: An update and bibliography. *Acta Archaeologica*. 62, 123-150.

Morris, C. D. 1993. The Birsay Bay project. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 285-307.

Morris, C. D. forthcoming a. *The Birsay Bay Project Volume 2*.

Morris, C. D. forthcoming b. The northern cliff area excavations: Stratigraphy and structures. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Morris, C. D. forthcoming c. The southern cliff area excavations: Stratigraphy and structures. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Morris, C. D., Barrett, J. H. and Batey, C. E. 1994. The Viking and Early Settlement Archaeological Research Project. An archaeological research programme and recent results. In Ambrosiani, B. and Clarke, H. *The Twelfth Viking Congress: Developments around the Baltic and the North Sea in the Viking Age*. Stockholm, The Birka Project, 144-158.

Morris, C. D. and Cook, G. forthcoming. Radiocarbon dates. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Morris, C. D., Cook, G. and Stenhouse, M. J. 1989. Appendix 2: Radiocarbon dates. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 298-299.

Morris, C. D. and Emery, N. 1986. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland.* 116, 301-374.

Morris, C. D. and Rackham, D. J. 1989. Birsay Bay, Orkney: Human exloitation of natural and agricultural resources. *Hikuin*. 15, 207-222.

Morris, C. D., Rackham, D. J., Batey, C. E., Huntley, J. P., Jones, A. K. G. and O'Connor, T. P. 1992. Excavations at Freswick Links, Caithness 1980-82: Environmental column samples from the cliff-side. In Morris, C. D. and Rackham, D. J. *Norse and Latter Settlement and Subsistence in the North Atlantic*. Glasgow, University of Glasgow Department of Archaeology, 43-102.

Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others forthcoming a. *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Morris, C. D., Batey, C. E. and Rackham, D. J. forthcoming b. Overall discussion. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement.* Inverness, Highland Regional Council Monograph No. 1.

Morrison, I. A. 1978. Aspects of Viking small craft in light of Shetland practice. In Baldwin, J. R. *Scandinavian Shetland, An Ongoing Tradition?* Edinburgh, Scottish Society for Northern Studies, 57-75.

Mueller, J. 1975. *Sampling in archaeology.* Tucson, University of Arizona Press.

Murray, A. L. 1993. The salmon fishings of Strathnaver, 1558-1559. *Review of Scottish Culture.* 8, 77-83.

Murray, J. C. 1982. *Excavations in the Medieval Burgh of Aberdeen 1973-81.* Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 2.

Murray, J. C. n.d. Tuquoy, Westray, Orkney: The medieval pottery. Unpublished report submitted to O. Owen, Historic Scotland.

Muthesius, A. 1982. The silk fragment from 5 Coppergate. In MacGregor, A. Anglo-Scandinavian finds from Lloyds Bank, Pavement, and other sites. *The Archaeology of York.* 17/3, 67-174.

Muus, B. J. and Dahlstrøm, P. 1974. *Collins Guide to the Sea Fishes of Britain and North-Western Europe.* London, Collins.

Myhre, B. 1993. The beginning of the Viking Age - Some current archaeological problems. In Faulkes, A. and Perkins, R. *Viking Revaluations.* London, Viking Society for Northern Research, 182-204.

Mykura, W. 1974. The geological basis of the Shetland environment. In Goodier, R. *The Natural Environment of Shetland.* Edinburgh, The Nature Conservancy Council, 1-12.

Mykura, W. 1976. *British Regional Geology: Orkney and Shetland.* Edinburgh, HMSO.

Nedkvitne, A. 1976. Handelssjøfarten mellom Norge og England i Høymiddelalderen. *Sjøfartshistorisk Årbok.* 1976, 7-254.

Nicholson, R. A. 1991. An investigation into variability within archaeologically recovered assemblages of faunal remains: The influence of pre-depositional taphonomic processes. D.Phil., University of York.

Nicholson, R. A. 1992a. Bone survival: the effects of sedimentary abrasion and trampling on fresh and cooked bone. *International Journal of Osteoarchaeology.* 2, 79-90.

Nicholson, R. A. 1992b. An assessment of the value of bone density measurements to archaeoichthyological studies. *International Journal of Osteoarchaeology.* 2, 139-154.

Nicholson, R. A. 1993a. An investigation into the effects on fish bone of passage through the human gut: some experiments and comparisons with archaeological material. *Circaea.* 10, 38-51.

Nicholson, R. A. 1993b. A morphological investigation of burnt animal bone and an evaluation of its utility in archaeology. *Journal of Archaeological Science.* 20, 411-428.

Nicholson, R. A. n.d. a. The fish bones. In Buteux, S. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and Later Periods.*

Nicholson, R. A. n.d. b The fish bones from Pool, Sanday. Unpublished report.

Nicolaisen, W. F. H. 1976. *Scottish Place-Names*. London, B.T. Batsford.

Nicolaisen, W. F. H. 1982. Scandinavians and celts in Caithness: The place-name evidence. In Baldwin, J. R. *Caithness A Cultural Crossroads*. Edinburgh, Scottish Society for Northern Studies, 75-85.

Nieke, M. 1993. Penannular and related brooches: Secular ornament or symbol in action? In Spearman, R. M. and Higgitt, J. *The Age of Migrating Ideas*. Edinburgh, National Museums of Scotland, 128-134.

Noddle, B. 1976-1977. The animal bones from Buckquoy, Orkney. In Ritchie, A. Excavation of Pictish and Viking-age farmsteads at Buckquoy, Orkney. *Proceedings of the Society of Antiquaries of Scotland.* 108, 174-227.

Noddle, B. 1986. Animal bones. In Whittle, A., Keith-Lucas, M., Milles, A., Noddle, B., Rees, S. and Romans, J. C. C. *Scord of Brouster: An early agricultural settlement on Shetland, Excavations 1977-1979*. Oxford, Oxford University Committee for Archaeology, 132.

Noddle, B. forthcoming. Animal bone from Skaill. In Buteux, S. *Settlements at Skaill, Deerness, Orkney: Excavations by Peter Gelling of the Prehistoric, Pictish, Norse and later periods*.

Nordic Archaeological Abstracts 1990.

Norræna Fornfræða Fèlags 1834. *Saga Sverris Konungs, Fornmanna Sögur 8*. Kaupmannahöfn, Norræna Fornfræða Fèlags.

Norwegian Stockfish Exporters Association n.d. *Norwegian Stockfish*. Bergen, The Norwegian Stockfish Exporters Association.

Nye, S. M. forthcoming. Burnt material and charcoal. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1,

Nye, S. and Boardman, S. n.d. Charred plant material from excavations at Tuquoy, Westray, Orkney, 1982-1988. Unpublished report submitted to O. Owen, Historic Scotland.

Nye, S. M. and Donaldson, A. M. 1989. The botanical remains. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, MF IV E6-G10.

O'Connor, T. P. 1989. Bones from Anglo-Scandinavian levels at 16-22 Coppergate. *The Archaeology of York.* 15/3, 137-207.

O'Dell, A. C. 1939. *The Historical Geography of the Shetland Islands*. Lerwick, Manson.

O'Dell, A. C. 1953. A view of Scotland in the middle of the eighteenth century. *Scottish Geographical Magazine*. 69, 58-63.

Ogilvie, A. E. J. 1991. Climatic Changes in Iceland A.D. c.865 to 1598. *Acta Archaeologica*. 61, 233-251.

Omand, C. J. 1986. The life of Saint Findan. In Berry, R. J. and Firth, H. N. *The People of Orkney*. Kirkwall, The Orkney Press, 284-287.

Omand, D. M., J. 1989. Settlements. In Omand, D. *The New Caithness Book*. Wick, North of Scotland Newspapers, 118-140.

Ordnance Survey 1968. *Ordnance Survey 1:2500 Plan ND3873 & ND 3973*. Chessington, Surrey, Director General of the Ordnance Survey.

Ordnance Survey 1984. *Cape Wrath Sheet 9 1:50 000 Landranger Series*. Southampton, Ordnance Survey.

Ordnance Survey 1988. *Strathnaver Sheet 10 1:50 000 Landranger Series*. Southampton, Ordnance Survey.

Ordnance Survey 1989. *Northern Scotland 1:250 000*. Southampton, Ordnance Survey.

Ordnance Survey 1993. *Loch Assynt Sheet 15 1:50 000 Landranger Series*. Southampton, Ordnance Survey.

Orr, M. Y. and Green, R. S. 1956. Report on organic remains. In Hamilton, J. R. C. *Excavations at Jarlshof*. Edinburgh, HMSO, 211.

Orton, C. R. and Hodson, F. R. 1981. Rank and class: Interpreting the evidence from prehistoric cemeteries. In *Mortality and Immortality: The anthropology and archaeology of Death*. New York, Academic Press, 103-115.

Owen, J. F. 1994. Analysis of coastal middens in south-eastern Australia: Selectivity of angling and other fishing techniques related to Holocene deposits. *Journal of Archaeological Science*. 21, 11-16.

Owen, O. A. 1993. Tuquoy, Westray, Orkney: A challenge for the future? In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 318-339.

Owen, O. A. and Dalland, M. 1994. Scar, Sanday: A Viking boat-burial from Orkney. An interim report. In Ambrosiani, B. and Clarke, H. *The Twelfth Viking Congress: Developments around the Baltic and the North Sea in the Viking Age*. Stockholm, The Birka Project, 159-172.

Owen, O. A. and Smith, B. 1988. Kebister, Shetland: An armorial stone, and an archdeacon's teind barn? *Post-Medieval Archaeology*. 22, 1-20.

Pálsson, H. and Edwards, P. 1976. *Egil's Saga*. London, Penguin Books.

Pálsson, H. and Edwards, P. 1981. *Orkneyinga Saga: The history of the earls of Orkney*. London, Penguin Books.

Pálsson, H. and Edwards, P. 1987. *Magnus' Saga*. Oxford, The Perpetua Press.

Pálsson, H. and Edwards, P. 1989. *Eyrbyggja Saga*. London, Penguin Books.

Parker-Pearson, M. 1984. Economic and ideological change: Cyclical growth in the pre-state societies of Jutland. In Miller, D. and Tilley, C. *Ideology, Power and Prehistory*. Cambridge, Cambridge University Press, 69-92.

Parmalee, P. W. 1985. Identification and interpretation of archaeological derived animal remains. In R.I. Gilbert, J. and Mielke, J. H. *The Analysis of Prehistoric Diets*. London, Academic Press, 61-95.

Parry, M. L. 1975. Secular climate change and marginal land. *Transactions of the Institute of British Geographers*. 64, 1-13.

Parry, M. L. 1976. The significance of the variability of summer weather in upland Britain. *Weather*. 31, 212-217.

Parry, M. L. 1978. *Climate Change, Agriculture and Settlement*. Folkestone, Dawson.

Parry, M. L. and Carter, T. R. 1985. The effect of climate variation on agricultural risk. *Climatic Change*. 7, 99-110.

Payne, S. 1972. Partial recovery and sample bias: The results of some sieving experiments. In Higgs, E. S. *Papers in Economic Prehistory*. Cambridge, Cambridge University Press, 65-81.

Payne, S. 1973. Kill-off patterns in sheep and goats: The mandibles from Asvan Kale. *Anatolian Studies*. 23, 281-303.

Payne, S. 1975. Partial recovery and sample bias. In Clason, A. T. *Archaeozoological Studies*. New York, American Elsevier Publishing Company, Inc., 7-17.

Payne, S. 1992. Some notes on sampling and sieving for animal bones. *Ancient Monuments Laboratory Report*. 55/92, London. English Heritage.

Payne, S. and Munson, P. J. 1985. Ruby and how many squirrels? The destruction of bones by dogs. In Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. G. A. *Palaeobiological Investigations: Research design, methods and data analysis*. Oxford, British Archaeological Reports International Series 266, 31-39.

Pearsall, D. M. 1989. *Paleoethnobotany: A handbook of Procedures*. London, Academic Press.

Peglar, S. 1979. A radiocarbon-dated pollen diagram from Loch of Winless, Caithness, north-east Scotland. *New Phytologist*. 82, 245-263.

Pennant, T. 1979[1774]. *A Tour of Scotland in 1769*. Perth, Melven Press.

Pennie, I. 1982a. Bird life. In Omand, D. *The Sutherland Book*. Golspie, The Northern Times Limited, 104-117.

Pennie, I. 1982b. Other wild life. In Omand, D. *The Sutherland Book*. Golspie, The Northern Times Limited, 118-131.

Perdikaris, S. forthcoming. The transition to a commercial economy: Lofoten fishing in the Middle Ages, a preliminary report. In *Proceedings of the International Council for Archaeozoology, Konstanz, Germany, October 1994*.

Perkins, D. 1973. A critique on the methods of quantifying faunal remains from archaeological sites. In Matolcsi, J. *Domestikationsforschung und Geschichte der Haustiere*. Budapest, Akadémiai Kiadó, 367-369.

Peske, L. 1994. Príspevek k poznání pocátku dojení skotu v praveku. *Archeologické Rozhledy*. 46, 97-104.

Peterkin, A. 1820. *Rentals of the Ancient Earldom and Bishoprick of Orkney*. Edinburgh, John Moir.

Platt, M. I. 1956. Report on the animal bones. In Hamilton, J. R. C. *Excavations at Jarlshof*. Edinburgh, HMSO, 212-215.

Polanyi, K. 1963. Ports of trade in early societies. *Journal of Economic History*. 23, 30-45.

Polanyi, K. 1978. Trade, markets and money in the European Early Middle Ages. *Norwegian Archaeological Review*. 11.

Pope, A. 1979[1774]. Of Caithness, Strathnaver and Sutherland. In Pennant, T. *A Tour of Scotland in 1769*. Perth, Melven Press, 318-346.

Porter, J. 1994. *Bandamanna Saga*. Felinfach, Llanerch.

Poulsen, J. H. W. and Zachariasen, U. 1971. *Syðabrævið*. Tórshavn, Føroya Fróðskaparfelag.

Pounds, N. J. G. 1994. *An Economic History of Medieval Europe*. London, Longman.

Powell, J., Powell, J., Low, D. and Gourlay, R. 1991. Balnakeil Bay Viking burial. *Discovery & Excavation in Scotland*. 1991, 46.

Power, E. 1928. *The Goodman of Paris*. London, George Routledge & Sons Ltd.

Power, R. 1990. Scotland in the Norse Sagas. In Simpson, G. *Scotland and Scandinavia 800-1800*. Edinburgh, John Donald, 13-24.

Prange, H. D., Anderson, J. F. and Rahn, H. 1979. Scaling of skeletal mass to body mass in birds and mammals. *The American Naturalist*. 113, 103-122.

Prestwich, M. 1967. Victualling estimates for English garrisons in Scotland during the fourteenth century. *English Historical Review*. 82, 536-541.

Pryde, G. S. 1965. *The Burghs of Scotland: A critical list*. Glasgow, Oxford University Press.

Rackham, D. J. 1986. An analysis of the animal remains. In Morris, C. D. and Emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 116, 301-374.

Rackham, D. J. 1989. Excavations beside the Brough Road, Birsay: The biological assemblage. In Morris, C. D. *The Birsay Bay Project Volume 1: Brough Road Excavations 1976-1982*. Durham, University of Durham, Department of Archaeology Monograph Series Number 1, 231-272, MF IV A5-G10.

Rackham, D. J. forthcoming. General environmental analysis. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Rackham, D. J., Batey, C. E., Jones, A. K. G. and Morris, C. D. 1984. Freswick Links, Caithness. report on environmental survey 1979. *Circaea*. 2, 29-55.

Rackham, D. J., Allison, E., Colley, S., Lamden, B., Nye, S. and Owen, M. forthcoming a. Excavations at Beachview Burnside Area A: The biological assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Rackham, D. J., Allison, E., Colley, S., Lamden, B., Nye, S. and Owen, M. forthcoming b. Beachview "Studio Site", Area 1 Sub-areas D/E: The biological assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Rackham, D. J., Allison, E., Colley, S., Lamden, B., Nye, S. and Owen, M. forthcoming c. Excavations at Beachview Studio Site, Area 1: The biological assemblage. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Rackham, D. J., Allison, E., Colley, S., Lamden, B. and Nye, S. forthcoming d. Environmental evidence. In Morris, C. D. *The Birsay Bay Project Volume 2*.

Radford, C. A. R. 1962. Art and architecture: Celtic and Norse. In Wainwright, F. T. *The Northern Isles*. Edinburgh, Thomas Nelson and Sons Ltd., 163-187.

Randsborg, K. 1980. *The Viking Age in Denmark: The formation of a state*. London, Duckworth.

Randsborg, K. 1982. Rank, rights and resources - an archaeological perspective from Denmark. In Renfrew, C. and Shennan, S. *Ranking, Resource and Exchange*. Cambridge, Cambridge University Press, 132-139.

Randsborg, K. 1991. *The First Millennium A.D. in Europe and the Mediterranean*. Cambridge, Cambridge University Press.

Rains, M. J. and Morris, C. D. forthcoming. The central cliff area excavations: Stratigraphy and structures. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

RCAMS Royal Commission on the Ancient Monuments of Scotland 1911a. *Second Report and Inventory of Monuments and Constructions in the County of Sutherland*. Edinburgh, HMSO.

RCAMS Royal Commission on the Ancient Monuments of Scotland 1911b. *Third Report and Inventory of Monuments and Constructions in the County of Caithness*. Edinburgh, HMSO.

RCAMS Royal Commission on the Ancient Monuments of Scotland 1946a. *Twelfth Report with an Inventory of the Ancient Monuments of Orkney & Shetland Volume II Inventory of Orkney*. Edinburgh, HMSO.

RCAMS Royal Commission on the Ancient Monuments of Scotland 1946b. *Twelfth Report with an Inventory of the Ancient Monuments of Orkney & Shetland Volume III Inventory of Shetland*. Edinburgh, HMSO.

Reed, C. A. 1963. Osteo-archaeology. In Brothwell, D., Higgs, E. and Clark, G. *Science in Archaeology: A Comprehensive Survey of Progress and Research*. London, Thames & Hudson, 204-216.

Reed, I. W. 1990. *1000 Years of Pottery: An analysis of pottery trade and use*. Trondheim, Riksantikvaren, Utgravningskontoret for Trondheim.

Reichstein, H. 1989. Zur frage der quantifizierung archaozoologischer daten: ein losbares problem? *Archaologisch Informationen*. 12, 144-160.

Reitz, E. J. and Cordier, D. 1983. Use of allometry in zooarchaeological analysis. In Grigson, C. and Clutton-Brock, J. *Animals and archaeology: 2 shell middens, fishes and birds*. Oxford, British Archaeological Reports, 237-252.

Reitz, E. J., Quitmyer, I. R., Hale, H. S., Scudder, S. J. and Wing, E. S. 1987. Application of allometry to zooarchaeology. *American Antiquity*. 52, 304-317.

Renfrew, C. and Buteux, S. 1985. Radiocarbon dates from Orkney. In Renfrew, C. *The Prehistory of Orkney*. Edinburgh, Edinburgh University Press, 263-274.

Reuter, T. 1985. Plunder and tribute in the Carolingian Empire. *Transactions of the Royal Historical Society*. 35, 75-94.

Rindos, D. 1984. *The Origins of Agriculture: An evolutionary perspective*. London, Academic Press.

Ringrose, T. J. 1988. Exploratory multivariate analysis of stratigraphic data: Armstrong's data from Pin Hole Cave reexamined. In Slater, E. A. and Tate, J. O. *Science and Archaeology Glasgow 1987*. Oxford, British Archaeological Reports British Series 196, 521-539.

Ringrose, T. J. 1992. Bootstrapping and correspondence analysis in archaeology. *Journal of Archaeological Science*. 19, 615-629.

Ringrose, T. J. 1993. Bone counts and statistics: A critique. *Journal of Archaeological Science*. 20, 121-157.

Ritchie, A. 1974. Pict and Norseman in northern Scotland. *Scottish Archaeological Forum*. 6, 23-36.

Ritchie, A. 1976-1977. Excavation of Pictish and Viking-age farmsteads at Buckquoy, Orkney. *Proceedings of the Society of Antiquaries of Scotland.* 108, 174-227.

Ritchie, A. 1993. *Viking Scotland*. London, B.T. Batsford Ltd/Historic Scotland.

Ritchie, P. R. 1984. Soapstone quarrying in Viking lands. In Fenton, A. and Palsson, H. *The Northern and Western Isles in the Viking World.* Edinburgh, John Donald, 59-84.

Ritchie, W. and Mather, A. 1970. *The Beaches of Caithness: A survey of the beach, dune and dune pasture area of Caithness.* Aberdeen, Department of Geography, University of Aberdeen.

Robberstad, K. 1983. Udal Law. In Withrington, D. J. *Shetland and the Outside World 1469-1969*. Oxford, Oxford University Press, 49-68.

Robertson, W. N. 1969. A viking grave found at the Broch of Gurness, Aikerness, Orkney. *Proceedings of the Society of Antiquaries of Scotland.* 101, 289-290.

Rogers, M., Allen, R., Nagle, C. and Fitzhugh, W. 1983. The utilization of rare earth element concentrations for the characterization of soapstone quarries. *Archaeometry*. 25, 186-195.

Rösener, W. 1992. *Peasants in the Middle Ages*. Cambridge, Polity Press.

Ross, J. 1882. Curing and preserving fish in Scotland and its islands. In Herbert, D. *Fish and Fisheries, a Selection from the Prize Essays of the International Fisheries Exhibition, Edinburgh 1882*. Edinburgh, William Blackwood & Sons, 106-129.

Ross, J. 1994. A description of the mineral and organic material in Late Norse pottery from Robert's Haven, Caithness, Scotland. Unpublished report.

Ross, L. 1982. The Stone Objects. In McGavin, N. A. Excavations in Kirkwall, 1978. *Proceedings of the Society of Antiquaries of Scotland.* 392-436.

Ross, S., Omand, D. and Futty, D. 1982. The landscape. In Omand, D. *The Sutherland Book*. Golspie, The Northern Times Limited, 41-61.

Rowley-Conwy, P. 1983. The animal and bird bones. In Hedges, J. W. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 73-124.

Samson, R. 1987. Social structure from Reihengräber: Mirror or mirage? *Scottish Archaeological Review*. 4, 116-126.

Sawyer, P. H. 1976. Harald Fairhair and the British Isles. In Boyer, R. *Les Vikings et Leur Civilisation*. Paris, Mouton, 105-112.

Sawyer, P. H. 1978. Wics, kings and vikings. In Andersson, T. and Sandred, K. I. *The Vikings: Proceedings of the symposium of the faculty of arts of Uppsala University June 6-9, 1977*. Stockholm, Almqvist & Wiksell International, 23-31.

Sawyer, P. H. 1982. *Kings and Vikings*. London, Methuen.

Sawyer, P. H. 1986. Early fairs and markets in England and Scandinavia. In Anderson, B. L. and Latham, A. J. H. *The Market in History*. London, Croom Helm, 59-77.

Sawyer, P. H. 1988. Dioceses and parishes in twelfth-century Scandinavia. In Crawford, B. *St. Magnus Cathedral and Orkney's Twelfth Century Renaissance*. Aberdeen, Aberdeen University Press, 36-45.

Sawyer, P. H. 1989. Coins and commerce. In Jonsson, K. and Malmer, B. *Sigtuna Papers: Proceedings of the Sigtuna Symposium on Viking-age Coinage 1-4 June 1989*. London, Spink & Son Ltd., 283-288.

Sawyer, B. and Sawyer, P. 1993. *Medieval Scandinavia*. Minneapolis, University of Minnesota Press.

Schäfer, D. 1888. *Hanserecesse, Dritter Band*. Leipzig, Verlag Von Duncker & Humblot.

Schia, E. 1987. M. 14C - Dateringer. In Schia, E. *De Arkeologiske Utgravninger i Gamlebyen, Oslo Bind 3*. Alvheim & Eide, 489-492.

Schmidt-Nielsen, K. 1984. *Scaling: Why is Animal Size so Important*? Cambridge, Cambridge University Press.

Seller, T. J. 1982. Bone material. In Curle, C. L. *Pictish and Norse Finds from the Brough of Birsay 1934-74*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 1, 132-138.

Seller, T. J. 1986. Animal bone material. In Hunter, J. R. *Rescue Excavations on the Brough of Birsay 1974-82*. Edinburgh, Society of Antiquaries of Scotland Monograph Series Number 4, 208-216.

Sephton, J. 1899. *The Saga of King Sverri of Norway*. London, David Nutt.

Serjeantson, D. 1988. Archaeological and ethnographic evidence for seabird exploitation in Scotland. *Archaeozoologia*. 2, 209-224.

Serjeantson, D. 1989. Introduction. In Serjeantson, D. and Waldron, T. *Diet and Crafts in Towns*. Oxford, British Archaeological Reports British Series 199, 1-12.

Serjeantson, D. forthcoming. *The bird bones from Pool*.

Service, E. R. 1962. *Primitive Social Organization: An evolutionary perspective*. New York, Random House.

Service, E. R. 1971. *Primitive Social Organization: An evolutionary perspective. Revised Edition*. New York, Random House.

Sharples, N. 1990. Upper Scalloway (Scalloway parish). *Discovery & Excavation in Scotland*. 1990, 48-49.

Shaw, F. J. 1980. *The Northern and Western Islands of Scotland: Their economy and society in the seventeenth century*. Edinburgh, John Donald.

Shawcross, W. 1972. Energy and ecology: Thermodynamic models in archaeology. In Clarke, D. L. *Models in Archaeology*. London, Methuen, 577-622.

Shennan, S. 1988. *Quantifying Archaeology*. Edinburgh, Edinburgh University Press.

Shetelig, H. 1945. The Viking graves in Great Britain and Ireland. *Acta Archaeologica*. XVI, 1-55.

Silver, I. A. 1969. The ageing of domestic animals. In Brothwell, D. and Higgs, E. S. *Science in Archaeology. A survey of progress and research*. London, Thames & Hudson, 283-302.

Sibbald, R. 1845[1711]. *Description of the Islands of Orkney and Zetland by Robert Monteith of Eglisha and Gairsa, 1633*. Edinburgh, Thomas G. Stevenson.

Sidell, E. J. forthcoming. Eggshell. In Morris, C. D., Batey, C., Jones, A. K. G., Rackham, D. J., Rains, M. J. and Others *Freswick Links Caithness: Excavation and survey of a Norse settlement*. Inverness, Highland Regional Council Monograph No. 1.

Sigurdsson, H. 1984. Some landmarks in Icelandic cartography down to the end of the sixtenth century. *Arctic*. 37, 389-401.

Simpson, I. A. 1993. The chronology of anthropogenic soil formation in Orkney. *Scottish Geographical Magazine*. 109, 4-11.

Simpson, I. A. 1994. Spatial constraints on anthropogenic soil formation in Orkney. *Scottish Geographical Magazine*. 110, 100-104.

Simpson, I. and Barrett, J. H. forthcoming. Interpretation of midden formation processes at Robert's Haven, Caithness, Scotland, using thin section micromorphology. *Journal of Archaeological Science*.

Simpson, W. D. 1961. *The Castle of Bergen and the Bishop's Palace at Kirkwall: A study in early Norse architecture*. Edinburgh, Oliver and Boyd.

Skene, W. F. 1993[1872]. *John of Fordun's Chronicle of the Scottish Nation*. Edinburgh, Edmonston and Douglas.

Skjølsvold, A. 1961. *Klebersteinsindustrien i Vikingetiden*. Bergen, Universitetsforlaget.

Skjølsvold, A. 1976. Forhistorisk klebersteinsindustri i Lesjafjellene. *Universitetets Oldsaksamling Årbok 1972-4*.

Skovgaard-Petersen, I. 1981. The historical context of the first towns in Northern and Eastern Europe. In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 9-18.

Slade, H. G. and Watson, G. 1989. St. Peter's Kirk, Thurso, Caithness c 1150-1832. *Proceedings of the Society of Antiquaries of Scotland.* 119, 297-325.

Small, A. 1966. Excavations at Underhoull, Unst, Shetland. *Proceedings of the Society of Antiquaries of Scotland*. 98, 225-248.

Small, A. 1968. The historical geography of the Norse Viking colonization of the Scottish Highlands. *Norsk Geografisk Tidsskrift.* 22, 1-16.

Small, A. 1969. The distribution of settlement in Shetland and Faroe in Viking times. *Saga-Book.* 17, 145-155.

Small, A. 1971. The Viking Highlands - A geographical view. In *The Dark Ages in the Highlands*. Inverness, Inverness Field Club, 69-90.

Small, A., Thomas, C. and Wilson, D. M. 1973. *St. Ninian's Isle and its Treasure Volume 1*. Oxford, Oxford University Press.

Smart, V. 1985. The penny in the pennylands: Coinage in Scotland in the early middle ages. *Northern Studies*. 22, 65-70.

Smelsner, N. 1959. A comparative view of exchange systems. *Economic Development and Culture Change*. 7, 173-182.

Smith, A. forthcoming. The steatite from Pool.

Smith, B. 1980. Stock-stove houses. *Shetland Folk Book*. 7, 22-27.

Smith, B. and Turner, V. 1989. Upper Scalloway (Scalloway parish). *Discovery & Excavation in Scotland.* 1989, 68.

Smith, B. D. 1975. Toward a more accurate estimation of the meat yield of animal species at archaeological sites. In Clason, A. T. *Archaeozoological Studies*. New York, American-Elsevier, 99-106.

Smith, H. D. 1984. *Shetland Life and Trade 1550-1914*. Edinburgh, John Donald.

Smyth, A. P. 1972. The earliest Irish annals: Their first contemporary entries and the earliest centres of recording. *Proceedings of the Royal Irish Academy*. C72, 1-48.

Smyth, A. P. 1977. *Scandinavian Kings of the British Isles, 850-880*. Oxford, Oxford University Press.

Smyth, A. P. 1978. The chronology of Northumbrian history in the ninth and tenth centuries. In Hall, R. A. *Viking Age York and the North*. London, Council for British Archaeology Research Report No 27, 8-10.

Smyth, A. P. 1984. *Warlords and Holy Men: Scotland AD 80-1000*. London, Edward Arnold.

Sommerfelt, A. 1958. On the Norse form of the name of the Picts and the date of the first Norse raids on Scotland. *Lochlann*. 1, 218-222.

Stallibrass, S. 1990. Canid damage to animal bones: Two current lines of research. In Robinson, D. E. *Experimentation and reconstruction in environmental archaeology*. Oxford, Oxbow Books, 151-165.

Steane, J. M. and Foreman, M. 1988. Medieval Fishing Tackle. In Aston, M. *Medieval Fish, Fisheries and Fishponds in England*. Oxford, British Archaeological Reports British Series 182, 137-186.

Stein, J. K. 1992. Sediment analysis of the British Camp shell midden. In Stein, J. K. *Deciphering a Shell Midden*. Orlando, Academic Press, 135-162.

Stenhouse, M. J. and Hedges, J. W. 1983. The radiocarbon dating. In Hedges, J. W. Trial excavations on Pictish and Viking settlements at Saevar Howe, Birsay, Orkney. *Glasgow Archaeological Journal*. 10, 73-124.

Stevenson, A. 1988. Trade with the south, 1070-1513. In Lynch, M., Spearman, M. and Stell, G. *The Scottish Medieval Town*. Edinburgh, John Donald, 180-206.

Stevenson, J. 1991. *A Medieval Chronical of Scotland, The Chronicle of Melrose*. Lampeter, Llanerch Press.

Stevenson, R. B. K. 1966. *Sylloge of Coins of the British Isles National Museum of Antiquities of Scotland. Part I. Anglo-Saxon Coins*. London, Oxford University Press.

Stevenson, R. B. K. 1968. The brooch from Westness, Orkney. In Niclasen, B. *The Fifth Viking Congress*. Tórshavn, Føroya Landsstyri, 25-31.

Stevenson, R. B. K. 1986. The Anglo-Saxon silver penny and its context. In Morris, C. D. and emery, N. The chapel and enclosure on the Brough of Deerness, Orkney: Survey and excavations, 1975-1977. *Proceedings of the Society of Antiquaries of Scotland*. 301-374.

Stevenson, R. B. K. 1989. The Celtic brooch from Westness, Orkney, and hinged-pins. *Proceedings of the Society of Antiquaries of Scotland*. 119, 239-269.

Stewart, B. H. I. H. 1973. Some Edwardian hoards from Scotland. *The Numismatic Chronicle*. 13, 134-143.

Stewart, F. L. 1991. Floating for Fauna: Some methodological considerations using the Keffer site (AkGv-14) midden 57 faunal sample. *Canadian Journal of Archaeology*. 15, 97-116.

Stewart, F. L. and Stahl, P. W. 1977. Cautionary note on edible meat poundage figures. *American Antiquity*. 42, 267-271.

Stewart, K. M. and Gifford-Gonzalez, D. 1994. An ethnoarchaeological contribution to identifying hominid fish processing sites. *Journal of Archaeological Science*. 21, 237-248.

Stiner, M. C. 1991. The cultural significance of of Grotta Guattari reconsidered I. The faunal remains from Grotta Guattari: A taphonomic perspective. *Current Anthropology*. 32, 103-117.

Stone, J. 1991. *Illustrated Maps of Scotland from Blaeu's Atlas Novus of the 17th Century*. London, Studio Editions.

Storm, G. 1977[1888]. *Islandske Annaler Indtil 1578*. Oslo, Norsk Historisk Kjeldeskrift-institutt.

Stuart, J. and Burnett, G. 1878. *The Exchequer Rolls of Scotland Volume I*. Edinburgh, H.M. General Register House.

Stubbs, W. 1868. *Chronica: Magistri Rogeri de Houedene*. Volume I. London, Longmans, Green, Reader and Dyer.

Stubbs, W. 1871. *Chronica: Magistri Rogeri de Houedene*. Volume IV. London, Longman & Co., and Trübner & Co.

Sutherland, I. 1985. *From Herring to Seine Net Fishing on the East Coast of Scotland.* Wick, Campus Bookshop.

Sveinbjarnardóttir, G. 1991. Shielings in Iceland: an archaeological and historical survey. *Acta Archaeologica*. 61, 73-96.

Sveinbjarnardóttir, G. 1992a. *Farm Abandonment in Medieval and Post-Medieval Iceland: An interdisciplinary study*. Oxford, Oxbow Monograph 17.

Sveinbjarnardóttir, G. 1992b. Contact between Iceland and the European continent in the medieval period: The archaeological evidence. In Anonymous *Medieval Europe 1992 Exchange and Trade Pre-Printed Papers*. York, Medieval Europe 1992, 153-158.

Tait, I. 1995. Medieval coins in Shetland. *The New Shetlander*. 191, 12-13.

Talbot, E. 1970. Scrabster, Bishop's Castle. *Discovery and Excavation in Scotland*. 1970,

Talbot, E. 1973a. Scrabster, Bishop's Castle. *Discovery and Excavation in Scotland*. 1973, 21-22.

Talbot, E. 1973b. A report on excavations at Bishop's Castle, Scrabster. *Northern Studies*. 2, 37-39.

Talbot, E. 1974. Scandinavian Fortifications in the British Isles. *Scottish Archaeological Forum*. 6, 37-45.

Talbot, E. 1977. Watten, Clow Chapel. *Discovery and Excavation in Scotland*. 1977, 11.

Talbot, E. 1980. Clow, Chapel. *Discovery and Excavation in Scotland*. 1980, 17.

Taylor, A. B. 1938. *The Orkneyinga Saga*. Edinburgh, Oliver and Boyd.

Taylor, H. M. S. 1992. Aspects of land-use and settlement in prehistoric and historic Caithness. Ph.D., University of Edinburgh.

Theatrum Orbis Terrarum 1968[1636]. *Mercator - Hondius - Janssonius Atlas or a Geographicke Description of the World*. Amsterdam 1968, Theatrum Orbis Terrarum Ltd.

Theiner, A. 1864. *Vetera Monumenta Hibernorum et Scotorum Historiam Illustrantia*. Rome, Typis Vaticanis.

Thomson, W. P. L. 1984. Fifteenth century depression in Orkney: The evidence of Lord Henry Sinclair's Rentals. In Crawford, B. E. *Essays in Shetland History*. Lerwick, The Shetland Times Ltd., 125-142.

Thomson, W. P. L. 1986a. St Findan and the Pictish-Norse transition. In Berry, R. J. and Firth, H. N. *The People of Orkney*. Kirkwall, The Orkney Press, 279-283.

Thomson, W. P. L. 1986b. Pict, Norse, Celt and lowland Scot. In Berry, R. J. and Firth, H. N. *The People of Orkney*. Kirkwall, The Orkney Press, 209-224.

Thomson, W. P. L. 1987. *History of Orkney*. Edinburgh, Mercat Press.

Thomson, W. P. L. 1993. Some settlement patterns in medieval Orkney. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 340-348.

Thorson, P. 1954. The third Norn dialect - that of Caithness. In Simpson, W. D. *The Viking Congress, Lerwick July 1950*. Edinburgh, Aberdeen University Studies No. 132, 230-238.

Thorson, P. 1968. Ancient Thurso, a religious and judicial centre. In Niclasen, B. *The Fifth Viking Congress*. Tórshavn, Føroya Landsstyri, 71-77.

Thorsteinsson, A. 1968. The viking burial place at Pierowall, Westray, Orkney. In Niclasen, B. *The Fifth Viking Congress*. Tórshavn, Føroya Landsstyri, 150-173.

Thorsteinsson, A. 1981. On the development of Faroese settlements. In Bekker-Nielsen, H., Foote, P. and Olsen, O. *Proceedings of the Eighth Viking Congress*. Odense, Odense University Press, 189-202.

Thowsen, A. 1969. The Norwegian exports of boats to Shetland, and its influence upon Shetland boatbuilding and usage. *Sjøfartshistorisk Arbok*. 1969, 145-208.

Thurborg, M. 1988. Regional economic structures: An analysis of the Viking Age silver hoards from Öland, Sweden. *World Archaeology*. 20, 302-324.

Tipping, R. n.d. Palynological and sedimentological evidence for the provenance of material in, and function of, 'the pit' at Tuquoy, Westray, Orkney. Unpublished report submitted to O. Owen, Historic Scotland.

Trigger, B. G. 1989. *A History of Archaeological Thought*. Cambridge, Cambridge University Press.

Trætteberg, H. 1975. Tyske Kontorsegl. *Kulturhistorisk Leksikon for Nordisk Middelalder*. XIX, 146-148.

Tschan, J. 1959. *Adam of Bremen, The Archbishops of Hamburg Bremen*. New York, Columbia University Press.

Turner, V. W. 1971. An anthropological approach to the Icelandic Saga. In Beidelman, T. O. *The Translation of Culture*. London, Tavistock, 349-374.

Tylecote, R. F. 1986. *The Prehistory of Metallurgy in the British Isles*. London, The Institute of Metals.

Uerpmann, H. 1973. Animal bone finds and economic archaeology: A critical study of osteo-archaeological method. *World Archaeology*. 4, 307-322.

Urbanczyk, P. 1992. *Medieval Arctic Norway*. Warsaw, Institute of Archaeology and Ethnology.

Van Neer, W. and Muniz, A. M. 1992. Fish Middens. Anthropogenic accumulations of fish remains and their bearing on archaeoichthyological analysis. *Journal of Archaeological Science*. 19, 683-695.

Vilhjálmsson, V. 1992. Jewellery from female grave. In Roesdahl, E. and Wilson, D. M. *From Viking to Crusader: Scandinavia and Europe 800-1200*. Uddevalla, Nordic Council of Ministers, 312-313.

Vollan, O. 1959. Fisketilvirkning. *Kulturhistorisk Leksikon for Nordisk Middelalder*. 4, 343-344.

Vollan, O. 1974. Torskefiske. *Kulturhistorisk Leksikon for Nordisk Middelalder*. 18, 506-509.

von Brandt, A. 1984. *Fish Catching Methods of the World*. Farnham, Fishing News Books.

von den Driesch, A. 1994. Hyperostosis in fish. In Van Neer, W. *Fish Exploitation in the Past: Proceedings of the 7th meeting of the ICAZ fish remains working group*. Tervuren, Musee Royal de L'Afrique Centrale, 37-45.

Vretemark, M. 1994. Raw materials in urban comb manufactures in medieval Scandinavia. Paper presented at International Council for Archaeozoology 7th International Congress, Konstanz, Germany.

Wainwright, F. T. 1962a. Picts and Scots. In Wainwright, F. T. *The Northern Isles*. Edinburgh, Thomas Nelson and Sons Ltd., 91-116.

Wainwright, F. T. 1962b. The Scandinavian Settlement. In Wainwright, F. T. *The Northern Isles*. Edinburgh, Thomas Nelson and Sons Ltd., 117-162.

Walker, B. 1982. Scottish methods of preserving white fish. In Gailey, A. and Ohógáin, D. *Gold Under the Furze: Studies in folk tradition*. Dublin, The Glendale Press, 138-149.

Wallace, P. F. 1987. The economy and commerce of Viking Age Dublin. In Düwel, K. et al. *Untersuchungen zu Handel und Verkehr der vor - und Frühgeschichtlichen Zeit in Mittel- und Nordeuropa. Teil IV. Der Handel der Karolinger- und Wikingerzeit*. Göttingen, Abhandlungen der Akademie der Wissenschaften in Göttingen. Philo.-Hist. Klasse 3, Nr. 156, 200-245.

Walters, I. 1984. Gone to the dogs: A study of bone attrition at a central Australian campsite. *Mankind*. 14, 389-400.

Walters, M. 1980. *The Complete Birds of the World*. Newton Abbot. David & Charles.

Warner, R. 1976. Scottish silver arm-rings: An analysis of weights. *Proceedings of the Society of Antiquaries of Scotland*. 107, 136-143.

Watson, G. 1989. Communications. In Omand, D. *The New Caithness Book*. Wick, North of Scotland Newspapers, 180-186.

Watson, J. P. N. 1979. The estimation of the relative frequencies of mammalian species: Khirokitia 1972. *Journal of Archaeological Science*. 6, 127-137.

Watt, W. G. T. 1888. Notice of the discovery of a stone cist, with an Iron Age interment, at Skaill Bay. *Proceedings of the Society of Antiquaries of Scotland*. 22, 283-285.

Watt, D. E. R. 1969. *Fasti Ecclesiae Scoticanae Medii Aevi, AD Annum, 1638*. Edinburgh, Scottish Record Society.

Waugh, D. 1984. Caithness place-names. *Nomina*. 8, 15-28.

Waugh, D. J. 1985. The place-names of six parishes in Caithness, Scotland. Ph.D., University of Edinburgh.

Waugh, D. J. 1986. The place-names of Canisbay, Caithness. *Northern Scotland*. 7, 99-111.

Waugh, D. 1993. Caithness: An onomastic frontier zone. In Batey, C. E., Jesch, J. and Morris, C. D. *Caithness, Orkney and the North Atlantic in the Viking Age*. Edinburgh, Edinburgh University Press, 120-128.

Weatherley, A. H. and Gill, H. S. 1987. *The Biology of Fish Growth*. Toronto, Academic Press.

Weber, B. 1992. Norwegian exports in Orkney and Shetland during the Viking and Middle Ages. In Anonymous *Medieval Europe 1992 Exchange and Trade Pre-printed Papers*. York, Medieval York 1992, 159-167.

Weber, B. 1993. Norwegian reindeer antler export to Orkney. *Universitetets Oldsaksamling Årbok 1991/1992*. 161-174.

Weber, B. 1994. Iron Age Combs: Analyses of raw material. In Ambrosiani, B. and Clarke, H. *The Twelfth Viking Congress: Developments around the Baltic and the North Sea in the Viking Age*. Stockholm, The Birka Project, 190-193.

West, J. F. 1970. *The Journals of the Stanley Expedition to the Faroe Islands and Iceland in 1789*. Tórshavn, Føroya Fródskaparfelag.

Wheeler, A. 1969. *The Fishes of the British Isles and North-West Europe*. Toronto, Macmillan.

Wheeler, A.1976-1977. The fish bones from Buckquoy, Orkney. in Ritchie, A. Excavation of Pictish and Viking-Age farmsteads at Buckquoy, Orkney. *Proceedings of the Society of Antiquaries of Scotland*. 108, 174-227.

Wheeler, A. 1977. Fish Bone. In Clarke, H. and Carter, A. *Excavations in King's Lynn 1963-1970*. London, The Society for Medieval Archaeology Monograph Series: No. 7, 405-409.

Wheeler, A. 1978a. *Key to the Fishes of Northern Europe*. London, Frederick Warne Ltd.

Wheeler, A. 1978b. Problems of identification and interpretation of archaeological fish remains. In Brothwell, D. R., Thomas, K. D. and Clutton-Brock, J. *Research Problems in Zooarchaeology*. London, Institute of Archaeology, 69-75.

Wheeler, A. and Jones, A. K. G. 1989. *Fishes*. Cambridge, Cambridge University Press.

Wheeler, J. C. and Reitz, E. 1987. Allometric prediction of live weight in the Alpaca (*Lama pacos* L.). *Archaeozoologia*. 31-46.

White, S. 1992. Notes on carbonised plant remains from Robert's Haven, Caithness. Unpublished report.

White, T. E. 1953. A method of calculating the dietary percentage of various food animals utilized by aboriginal peoples. *American Antiquity*. 18, 396-398.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J. and Tortonese, E. 1986a. *Fishes of the North-eastern Atlantic and the Mediterranean Volume 2*. Paris, United Nations Educational, Scientific and Cultural Organization.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J. and Tortonese, E. 1986b. *Fishes of the North-eastern Atlantic and the Mediterranean Volume 3*. Paris, United Nations Educational, Scientific and Cultural Organization.

Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J. and Tortonese, E. 1989. *Fishes of the North-eastern Atlantic and the Mediterranean Volume 1*. Paris, United Nations Educational, Scientific and Cultural Organization.

Whitelock, D., Douglas, D. C. and Tucker, S. I. 1961. *The Anglo-Saxon Chronicle*. London, Eyre & Spottiswoode.

Whittington, G. 1986. The Roy Map: The protracted and fair copies - part one. *Scottish Geographical Magazine*. 83, 20-28.

Wigh, B. 1994. The animal bones from the Viking-Age town of Birka, Sweden. Paper presented at International Council for Archaeozoology 7th International Congress, Konstanz, Germany,

Wilkinson, M. 1979. The fish remains. In Maltby, M. *The Animal Bones from Exeter 1971-1975*. Sheffield, Exeter Archaeological Reports Volume 2, Department of Prehistory and Archaeology, University of Sheffield, 74-81.

Will, B. 1995. Report on the medieval ceramics from Robert's Haven, John O' Groats, Caithness. Unpublished report.

Wilson, B. 1985. Degraded bones, feature type and spatial patterning on an Iron Age occupation site in Oxfordshire, England. In Fieller, N. R. J., Gilbertson, D. D. and Ralph, N. G. A. *Palaeobiological Investigations: Research design, methods and data analysis*. Oxford, British Archaeological Reports International Series 266, 81-100.

Wilson, B., Grigson, C. and Payne, S. 1982. *Ageing and Sexing Animal Bones from Archaeological Sites*. Oxford, British Archaeological Reports British Series 109.

Wilson, D. M. 1976. Scandinavian settlement in the north and west of the Bitish Isles - an archaeological point-of-view. *Transactions of the Royal Historical Society*. 5th series, 26, 95-113.

Wilson, D. M. 1982. The Vikings and their use of wealth in the ninth and tenth centuries. *Saga och Sed*. 252-261.

Winder, N. P. 1991. How many bones make five? The art and science of guesstimation in archaeozoology. *International journal of Osteoarchaeology*. 1, 111-126.

Wing, E. S. and Brown, A. B. 1979. *Paleonutrition: Method and Theory in Prehistoric Foodways*. London, Academic Press.

Withrington, D. J. and Grant, I. R. 1978 [1791-1799]. *The Statistical Account of Scotland 1791-1799 Edited by Sir John Sinclair Volume XIX Orkney & Shetland*. East Ardsley, Wakefield, EP Publishing Limited.

Withrington, D. J. and Grant, I. R. 1979 [1791-1799]. *The Statistical Account of Scotland 1791-1799 Edited by Sir John Sinclair Volume XVIII Caithness and Sutherland*. East Ardsley, Wakefield, EP Publishing Limited.

Withrington, D. 1982. The 18th & 19th centuries. In Omand, D. *The Sutherland Book*. Golspie, The Northern Times Limited, 201-228.

Wobst, H. M. 1983. We can't see the forest for the trees: Sampling and the shapes of archaeological distributions. In Moore, J. A. and Keene, A. S. *Archaeological Hammers and Theories*. London, Academic Press, 38-85.

Wylie, A. 1985. The reaction against analogy. In Schiffer, M. B. *Advances in Archaeological Method and Theory Volume 8*. London, Academic Press, Inc., 63-111.

Ziegler, A. C. 1973. Inference from prehistoric faunal remains. *Addison-Wesley Module in Anthropology*. 43.

Zutter, C. 1991. Murals of Icelandic land-use during the Freestate. Paper presented at the 1991 C.A.A. Meeting, St. Johns Newfoundland.

Þorláksson, H. 1992. Social ideals and the concept of profit in thirteenth-century Iceland. In Pálsson, G. *From Sagas to Society: Comparative approaches to early Iceland*. Enfield Lock, Hisarlik Press, 231-245.

Þorsteinsson, B. 1969. *Enskar Heimildir um Sögu Islendinga A 15. og 16. Öld*. Reykjavík, Hid Islenzka Bókmenntafélag.