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An Archaeobotanical Investigation of Oakbank Crannog, a Prehistoric Lake Dwelling in Loch Tay, the Scottish Highlands.

Jennifer Jane Miller

Thesis submitted to the University of Glasgow for tl

degree of Ph.D.

Division of Environmental and Evolutionary Biolog

August 1997.

‘I would like to see the day when all archaeologists look

waterlogged deposits on a site and excitedly exclaim;

“Fantastic, we’ve got wet materials!”

instead of;

“Stop digging, we’ve hit water!” ’

Doran (1992 p132).

Dedicated to wetland archaeobotanists everywhere.

ABSTRACT

Oakbank crannog is a Late Bronze/Early Iron Age lake dwelling in Loch Tay, Scotland. The initial free-standing pile construction was rebuilt several times, resulting in an organic mound. The latest remaining consolidation phase incorporated large boulders which sealed the organic material underneath and preserved waterlogged remains of the plants utilised by earlier inhabitants.

The base-rich soil of the local environment around the dwelling supported a mixed oak woodland with alder carr in the wetter areas and fringing the loch. Parts of this were cleared for agriculture by the earliest settlers, and woodland trees were utilised to build the dwelling, most especially alder, but also frequently oak, hazel and birch, with others occasionally at low levels.

Cereal crops grown included *Hordeum vulgare, Triticum dicoccum* and *T. spelta*. Spelt wheat implies trade links with the south of the country or abroad. *Linum usitatissimum* was cultivated on a small scale, possibly together with *Papaver somniferum*, another species which has implications for trade.

The abundance of crop contaminant weed species emphasises the soil fertility, and suggests that cereal crops were neither weeded nor hand-picked on the ear. Seeds of low growing weeds indicate harvesting close to ground level. Processing was done for immediate use, at the doorway to the dwelling itself. Crop by-products including chaff and weed seeds were fed to livestock to supplement fodder. Tail grain and some prime barley may have been added or left intentionally during processing to supplement the feed. This generous use of valuable grain and edible weed seeds implies a healthy economy with adequate stores of food. Livestock were housed in the dwelling at least periodically, but were confined to specific areas.

The bulk of fodder for livestock was mixed hay cut from damp and wetter lowland meadows. No evidence of leaf or twig foddering was found. Pollen analysed from one goat dropping highlights the potential for further such studies, and concurs with the macrofossil evidence from the surrounding fodder. Summer transhumance to upland grazing is suggested to protect winter feed. The presence of seeds of the very rare montane *Rubus chamaemorus* in deposits provides further evidence for long range utilisation of resources.

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DECLARATION

I hereby declare that this thesis is composed of work carried out by myself unless otherwise acknowledged and cited, and that the thesis is of my own composition. The research was carried out in the period from October 1993 to July 1997, initially on a part-time and then a full-time basis. This dissertation has not in whole or in part been previously presented for any other degree.

Jennifer J. Miller, August 1997.

LIST OF ABBREVIATIONS FREQUENTLY USED

sp	species (singular)
spp	species (plural)
ssp	subspecies
subg	subgenus
var	variety
cf	compare
c.	*circa*
s.s.	*sensu strictu* (in the strictest sense)
s.l.	*sensu latu* (in the widest sense)
indet.	indeterminate
fgmt.	fragment
ab	abundant
co	common
dom	dominant
fq	frequent
occ	occasional
ra	rare
spa	sparse
vr	very rare

CHAPTER 1: INTRODUCTION

1.1. Background Principles of Archaeobotany and their Relevance to Archaeology

The identification of carbonised and waterlogged wood, seeds, fruits and vegetative parts of plants from archaeological sites provides invaluable information about social and economic principles of the community, especially with regard to agriculture, domestic activity and trade. When taken in conjunction with a detailed study of plant microfossils (pollen and spores) from a suitable location nearby, a comprehensive picture will also emerge of the environment before, during and after occupation, and the resultant anthropogenic changes.

Archaeological sites vary immensely in the amount of plant material they have retained. Many dry land sites divulge few plant macrofossils other than charcoal and carbonised crop assemblages lost during processing or in an accidental fire. In these cases the only reason for the preservation of macrofossils is their inert carbonised state which is resistant to decay. In general, carbonised assemblages are highly anthropogenic in origin, resulting from crop assemblages, wild plants and wood species selected for use on the site.

Uncarbonised plant remains may survive in land sites in specific areas where deposits have been continually or mostly waterlogged since deposition. Areas conducive to good preservation of waterlogged plant remains include deep pits and wells where the volume of organic material has retained sufficient moisture, ditches (especially in clay soils) which were cut below the level of the natural water table, and places where water has inundated or reclaimed the site. Waterlogged remains commonly yield more information regarding the local environment than carbonised ones. Nevertheless both types of assemblage also reveal those species selectively used by the occupants. This is most easily understood in the context of latrine fills. On well preserved land-based sites such as the towns of Aberdeen (Fraser & Dickson 1982), Perth (Robinson

1987) and York (e.g. Hall & Kenward 1990, Kenward & Hall 1995) the combination of carbonised and waterlogged remains provide a comprehensive picture of the economy of these communities.

As mentioned above, land based archaeological sites vary enormously in the extent and types of plant remains preserved. This is most obvious where waterlogged macrofossils are concerned. However, the situation is different when submerged sites are considered. A dwelling or settlement of huts from a flooded lake shore or mire community, or a crannog which has collapsed, will retain uncarbonised plant remains which are outstanding both in quality and quantity. In Scotland and Ireland many of the crannogs built either as stilted dwellings or on artificial islands in wetland areas remained untouched and with their organic remains intact until fairly recent times. The discovery of such sites in the last century often came as a result of land reclamation for agriculture or industry when lochs and boggy areas were drained. Early British excavators were little interested in the organic matrix binding the timbers and other artefacts, but more recent studies have revealed just how much archaeological information can be gleaned from the plant remains within the organic detritus. The high status of Buiston Crannog in Ayrshire became clear from the agricultural economy and discovery of plant species which must have been traded, including *Coriandrum sativum* (coriander) and *Anethum graveolens* (dill) (Holden 1996). This site was previously excavated in the late 19th century by Munro (1882), who although advanced for his time, still did not fully recognise the significance of the organic material that was shovelled away in barrow loads.

Before the excavation of Oakbank crannog initiated in 1980 (Dixon 1981, 1982a, 1984a, b) few wetland site studies recognised the potential for detailed archaeobotanical research The intensive work from the Somerset Levels initiated by Bulleid in 1892 (e.g. Bulleid 1958) showed the kinds of results possible, however. The Somerset Levels Project became a multi-disciplinary project encompassing many kinds of environmental analyses, thereby maximising the information to be gained from the archaeological remains (Coles 1987, Coles & Coles 1989). This thesis deals with the study of plant macrofossils from Oakbank crannog, Loch Tay. It attempts to assign potential uses for the plant species found within the matrix and describe the surrounding vegetation.

1.2. Wetland Sites in Britain and Europe

The definition of wetland archaeological sites includes those classified as submerged. The distinction comes with the degree to which a site is waterlogged, whether seasonally or permanently. A site which was initially built as a raised mound on a wetland area may become seasonally or permanently submerged as the peat-forming vegetation grows up and swamps it. Such is the case at Buiston Crannog, Ayrshire, where the modern water level fluctuates from 40cm below the surface in the summer to flooded in winter (Crone 1993). Glastonbury and Meare villages in the Somerset Levels are other examples where habitation sites built on mounds of brushwood and turves to stand proud of the wetland area become submerged under peat with the passage of time (e.g. Coles 1984, Coles 1987)

Many submerged archaeological sites are the result of either collapse or slippage of occupation sites into water or the rise of water levels to submerge dwellings built on the shoreline. The collapse in antiquity of crannogs built over free-standing water resulting in or following abandonment caused their subsidence onto the loch bed and consequent preservation in many cases. A combination of natural collapse following the prolonged exposure of a wooden construction to wet conditions and wave action and perhaps also increasing water levels may be responsible for many of the crannog sites in Scotland and Ireland. Several crannogs examined show evidence of reconstruction phases (e.g. Milton Loch 1; Piggott 1953, Guido 1974, Buiston; Crone 1991, Barber & Crone 1993, Oakbank; Dixon 1984a, b, Sands 1994). It is likely that this was normal in the battle to keep out the elements.

Lake-shore communities can also become submerged through the increase in water levels, either resulting in or following abandonment. However this water level rise was sometimes short lived such that resettlement was possible at a later date. At Charavines 'Les Baigneurs', Lake Paladru, France

(Bocquet *et al.* 1987) dendrochronology has indicated several phases of resettlement spanning some sixty years.

The general term 'lake dwellings' includes lake-shore settlements, mire communities and true crannogs, both those built on mounds and as free-standing pile dwellings. The definition of crannogs will be discussed more fully in the following section. Lake dwellings are known in both Britain and Europe, although the lake-shore settlements are more common in Europe. Wetland occupation sites span thousands of years from the Mesolithic Star Carr (Clarke 1954) and Tybrind Vig in Denmark (Andersen 1987). The Neolithic settlements in Switzerland and France are well known, (e.g. Keller 1866, Boquet *et al.* 1987, Egloff 1987, Ruoff 1987) and Bronze Age site include Fiavé and Lavagnone (Perini 1987) and Flag Fen (Pryor 1991). Wetland sites dated to the Iron Age include the Somerset Levels (e.g. Bulleid 1958, Coles & Coles 1989) and crannogs in Milton Loch 1 (Piggott 1953, Guido 1974) and the Isle of Lewis (Dixon & Topping 1986). Later dated sites include the dark age Buiston Crannog (Barber & Crone 1993) and medieval or later castle sites such as Eilean nan Breabane, Loch Tay (Dixon 1982b) and those at Loch an Duin in North Uist (Blundell 1913) and Loch Doon, Ayrshire (Fairbairn 1937). Crannogs in the strictest sense are only known in Scotland and Ireland, although mire communities such as those from the Somerset Levels and Flag Fen are found in England.

1.3. Crannogs

Crannogs are individual dwellings built over standing water, whether free-standing on stilts, or utilising a natural island, with or without adding to it artificially. An artist's impression of one type is shown in figure 1.1. (after Piggott 1953, figure 5). The earliest studies were done in the latter half of the 19th century, with a construction theory envisaged by Munro (1882) based solely on a mound built up over natural bedrock and stones in the Highlands or layers of brushwood, stones and turves in lowland areas. However, many substantially stone-built Highland crannogs have now been found to have a timber element too, e.g. Loch of Kinellan, Inverness-shire (Fraser 1917).

Figure 1.1. Artist's impression of a crannog (after Piggott 1953 figure 5)

It is likely that convenience and availability were more important than building to 'type', a phenomenon which would change with time anyway. Munro's theory that all crannogs were formed from built up mounds was accepted as fact until very recently, and many authors still believe this to be the case (e.g. Barber & Crone 1993, Mallory & McNeill 1991, Mitchell & Ryan 1997).

The excavation of Oakbank crannog, Loch Tay, has refuted this sweeping generalisation, however, (Dixon 1981, 1982a, 1984a, b), and further evidence from the same site brought about by Sands (1994) further confirms this point. The general lack of information about visible structural features on crannog sites means it is dangerous to attempt to define them neatly into mound or free-standing types (Dixon 1982b).

Crannogs in lochs exist today as small islands standing above the water level or as boulder mounds below its surface. Even the lowland crannogs with a high timber component have this boulder capping, and indeed it is this which has protected the organic mounds from the destructive influences of the water. It is highly probable that other crannog sites which did not have this boulder component added during some phase in their construction have now totally vanished. Indeed it may be that the latest occupation phases are missing from many sites as they were built on top of the stone-consolidated mound. Definite reasons for the incorporation of large boulders to the crannogs are unclear, but a combination of factors ranging from consolidation and stability to protection from elements and defence are envisaged. Crannogs built on raised areas in shallow pools as opposed to lochs have survived due to the overgrowth of a protective peat and water cover.

Crannogs as distinct from other types of lake dwellings are unique to Scotland and Ireland. The 1973 survey of Loch Awe (McArdle *et al.* 1973) highlighted twenty such sites in that loch alone, and seventeen are now known from Loch Tay (Dixon 1982b) with a possible eighteenth now found near the head of the loch (Dixon, pers comm). Morrison (1985) suggests that most if not all Scottish lochs may have remains of crannogs within them. It is likely that many of these were used for more than one occupation phase, with rebuilding in between. Scottish crannogs date from the Neolithic to the Medieval (Dixon

1984b). Wood-Martin (1886) cited 220 in Ireland, and now over four hundred are known from there (Dixon 1984b). Many of the Irish crannogs are Early Christian, however (Dixon 1984b, Crone 1993). None are known to exist in Wales with the exception of one in Llangorse Lake, Brecon, first recorded by Munro (1882). In England the sites reported from Suffolk and Norfolk meres by Munro (1882) are different in morphology to true crannogs (Dixon 1984b), and the Iron Age settlements of Glastonbury and Meare on the Somerset Levels are both extensive villages without the form of artificial islands, and with a greater diversity of function than many crannogs have (Dixon 1984b). The English wetland sites were occupied at the same time as the early Scottish sites, but are not known after approximately 200AD (Dixon 1984b), whereas Scottish sites persist into the 17th century (Dixon 1984b). This may reflect change in cultural practices in England which did not occur in Scotland until much later in the archaeological record

1.4. Previous Approaches to the Investigation of Waterlogged Sites

The history of crannog and lake-side settlement discovery and excavation from an archaeological perspective is outlined in Dixon (1984b, 1991) and Sands (1994).

Uncharacteristically low water levels in the Swiss lakes in the winter of 1853-4 exposed tips of piles emerging from the silts. Excavation of these revealed the remains of complex Neolithic settlements, and led to the publication of notices about the form and structure of these dwellings (Keller 1866). These early pioneers of this type of archaeological research were astute enough to recognise the importance of environmental remains in determining these early economies, and Heer (1866) was able to reveal agricultural and domestic activities from the examination of plant remains. Although entirely unsatisfactory by modern standards, this environmental work did highlight the potential for such studies in the future.

Early media publicity prior to publication from the Swiss lake settlements provided the impetus for work on Scottish sites (Stuart 1865). Keller's work on the Swiss lake settlements also inspired Munro (1882) whose *'Ancient Scottish*

Lake Dwellings' contained notices of all crannogs identified to date, as well as reports of his excavations of Lochlee, Lochspouts and Buiston Crannog in Ayrshire. Munro found the inhabitants of these settlements to be farmers, with evidence of crops and livestock, hunting, fishing and wild fruit gathering. As with the Swiss settlements, excavations were unsatisfactory by modern standards, and much environmental information was lost in the search for structures and artefacts. However Munro was methodical and meticulous in his recording, noting and describing crannogs found during land reclamation for agriculture. Information regarding these sites which are now drained and desiccated would have been lost if it were not for his efforts (Barber & Crone 1993).

Following the onset of the First World War until the excavation of Milton Loch 1 Crannog (Piggott 1953) few crannogs were studied, including Loch of Kinellan, Strathpeffer (Fraser 1917) and Eaderloch Crannog, Loch Treig (Ritchie 1942). Both depended on the fortuitous discovery of the sites following water level changes due to construction. The standard of excavation was poor, but revealed timber structures built on mounds of brushwood and stone. Little valid environmental evidence was gained. Dixon (1984b) suggests the possibility that descriptions such as these based on mound construction theories may have resulted from assumption following Munro's theory which by now was unquestioned. In some of these cases the mound seen may have been collapsed assorted organic material (including structural elements) overlying a further floor layer. In many cases the proximity to the surface of the water table precluded any deeper investigation such that this theory could not be excluded.

Milton Loch 1 Crannog (Piggott 1953) was the first to be excavated with standards approaching those used today. The site was drained, and flooding caused problems throughout the excavation. Nevertheless 300 upright piles and horizontal beams were revealed, along with evidence of cereal assemblages and quern stones. The brush mound theory was still accepted as fact. The site was dated to 200AD by a bronze artefact but a later reconsideration put earlier occupation phases to the early Iron Age (Guido 1974).

The re-examination of Buiston Crannog sponsored by Historic Scotland (Crone 1991, Barber & Crone 1993, Holden 1996) revealed a complex multi-phase high status site with a wealth of environmental information including plant macro and microfossils. Buiston more than any previous wetland sites has demonstrated the potential for information from archaeobotanical remains.

All these sites above were observed following drainage. However, superficial examination of submerged sites underwater was attempted as early as 1854 when Morlot utilised a glass-fronted bucket helmet and air hose to observe the Swiss lake villages (Sands 1994). Later Mapleton (1867) employed hard-hat divers to examine Loch Kielziebar, and Blundell (1909) dived in Loch Ness. However, these studies were only cursory, and retrieved little or no information regarding structures or economy. It was only with the development of the aqua-lung that underwater excavation could begin in earnest. The underwater excavation of settlements in Lake Neuchâtel, Switzerland (Egloff 1987), Lake Paladru, France (Bocquet *et al.* 1987) and Lakes Zürich and Greifen, Switzerland (Ruoff 1987) showed the benefits of underwater excavation. A detailed picture of structures, rebuilding phases, agriculture and the wider economy has now been obtained.

The importance of plant remains in interpreting the environment and economy was recognised at these sites.At 'Les Baigneurs' the entire organic matrix was sieved, with plant remains accounting for 95% of the total sediment (Bocquet *et al.* 1987). A comprehensive picture of the economy, chronology and environment around this several-phased Neolithic site has emerged as a direct result of plant remains studies. Other recent European botanical studies of wetland sites have been similarly rigorous, including Ammann *et al.* (1981), Dick (1989), Jacomet (1990) and Karg (1990). In Britain the only wetland studies in any way comparable to the European ones before Oakbank and Buiston were those from the Somerset Levels and Flag Fen, which differ from lake dwellings in type and composition. Oakbank is the first Scottish crannog excavated underwater to modern standards. The numerous, well preserved botanical remains retrieved have given detailed information about agricultural, domestic and wider economic practices in the area during the early Iron Age.

1.5. The Site of Oakbank Crannog

Environment. Oakbank crannog lies off-shore from Fearnan village at the north end of Loch Tay, Perthshire, Scotland (N.G.R. NN 72284425). Radiocarbon dates from structural timbers (table 1.1.) reported by Dixon (1984b), Crone (1993) and Sands (1994) suggest a Late Bronze or Early Iron Age occupation. Existing phases spanned approximately 400 years (Dixon 1984b, Sands 1994). Oakbank is one of 18 possibly similar sites in Loch Tay (figure 1.2.), all built on flat areas in shallow water near land with agricultural potential (Dixon 1982b, 1984b, Morrison 1985).

species/phase	Lab code	^{14}C date	calibrated date (1 σ)	calibrated date (2 σ)
oak pile early phase	GU-1323	2545±55 BP	800 (0.26) 750 cal BC 680 (0.74) 540 cal BC	810 (0.98) 480 cal BC 450 (0.02) 420 cal BC
oak pile early phase	GU-1325	2410±60 BP	760 (0.25) 690 cal BC 540 (0.75) 390 cal BC	770 (1.00) 380 cal BC
alder stake latest phase	GU-1463	2360±60 BP	760 (0.07) 710 cal BC 530 (0.93) 360 cal BC	800 (1.00) 200 cal BC
alder stake latest phase	GU-1464	2405±60 BP	760 (0.23) 700 cal BC 530 (0.77) 390 cal BC	770 (1.00) 380 cal BC
oak causeway pile	GU-3468	2490±50 BP	770 (1.00) 520 cal BC	790 (1.00) 410 cal BC
alder pile deep group	GU-3469	2560±50 BP	810 (0.39) 760 cal BC 680 (0.61) 550 cal BC	820 (1.00) 510 cal BC
oak pile deep group	GU-3470	2510±50 BP	780 (0.13) 750 cal BC 710 (0.87) 530 cal BC	800 (0.95) 480 cal BC 450 (0.05) 410 cal BC
alder pile deep group	GU-3471	2490±50 BP	770 (1.00) 520 cal BC	790 (1.00) 410 cal BC
alder pile deep group	GU-3472	2450±50 BP	760 (0.37) 680 cal BC 550 (0.63) 400 cal BC	770 (1.00) 400 cal BC

Table 1.1. Radiocarbon dates from structural timbers on Oakbank crannog. (OxCal version 2.14.)

Loch Tay is 24km long, and the northern reaches shelve very quickly to a depth of several hundred metres. The landscape topography reflects this, with steep hillsides running right down to the water's edge in many places. The southern end is much shallower and flatter by comparison. However, areas of flat or gently undulating cultivatable land do exist around the northern margins of the loch, and remains of crannogs have been found close to them. Loch Tay is fed to the south by the rivers Dochart and Lochay, and outflows at the northern end via the Tay. The shallow southern end has a high silt loading and is fairly eutrophic, a phenomenon further increased by modern fish farming. By contrast, the northern reaches of the loch near Oakbank have straight, exposed sides and deep water. The resultant stony margins, high wave action and low sedimentation rates support minimal numbers of submerged or marginal plants. It is unlikely that aquatic vegetation was ever extensive there.

The landscape around Loch Tay has been greatly altered by human activity since the time of Oakbank crannog. Extensive forest clearances and the accelerating impact on the hill lands are highlighted by pollen diagrams from the area such as Donner (1962) and Tipping *et al.* (1993). Aesthetic 'improvements' made by the Marquis of Breadalbane for Queen Victoria's visit included extensive *Picea* plantations, and the increasing trend for quality individual housing has further spread onto flatter areas of the landscape. Nevertheless, isolated pockets of unadulterated alder carr encroaching on to the water's edge and mixed oak and birch woods on drier soils give a suggestion of the natural woodland. The 30 hectares or so of gently sloping south-facing land around Oakbank could have supported agriculture (figure 1.2.).

The crannogs in Loch Tay now remain as flat, boulder-topped mounds. Several are small islands, some are exposed by low summer water levels, but others including Oakbank are permanently underwater. Oakbank is the only submerged crannog in the British Isles to have undergone intensive excavation using modern archaeological techniques. This was led by Dr Nicholas Dixon.

<u>Excavations.</u> Dixon (1982b) recorded a flat, boulder-topped mound some 30m off-shore at its nearest point, 14m x 18m long by 1.5-2.5m high with a small structure to one side (figure 1.3.). Axe marks on timbers of this latter suggest it was built with the earliest phase of the main mound (Sands 1994). Dixon's excavations have revealed that the dwelling was a free-standing pile structure accessed by a stilted walkway in its earliest phase. The depth of organic habitation detritus on the loch bed means that this first phase did not involve the deposition of the large boulders now seen on the site. His excavations show the dwelling had undergone several phases of reconstruction and consolidation, and the numerous piles recovered demonstrated the potential for

further work here. Examination of axe marks on pile tips coupled to the relative chronology devised by Crone (1988) enabled Sands (1994) to highlight the timbers used in various construction and consolidation phases. The final remaining habitation phase of Oakbank crannog may have been a mound on top of which further structures were built but have not survived (Sands 1994).

Figure 1.3. shows the site plan for Oakbank. Shaded areas show where samples for this study were taken from. Only 25% of the total volume of site has been excavated. Area A3 has been totally excavated to loch bed level, but others still have a good depth of organic matrix remaining. This contains layers of organic detritus interspersed with lenses of gravel and silt. Piles driven into the loch bed for the first phase of construction (GU-1323 & 1325, table 1.1.) contrast with later phases whose points are embedded in the organic mass. The latest remaining phase is represented by a number of alder partition stakes in area B3 embedded only 20cm into the matrix (GU-1463 & 1464, table 1.1.).

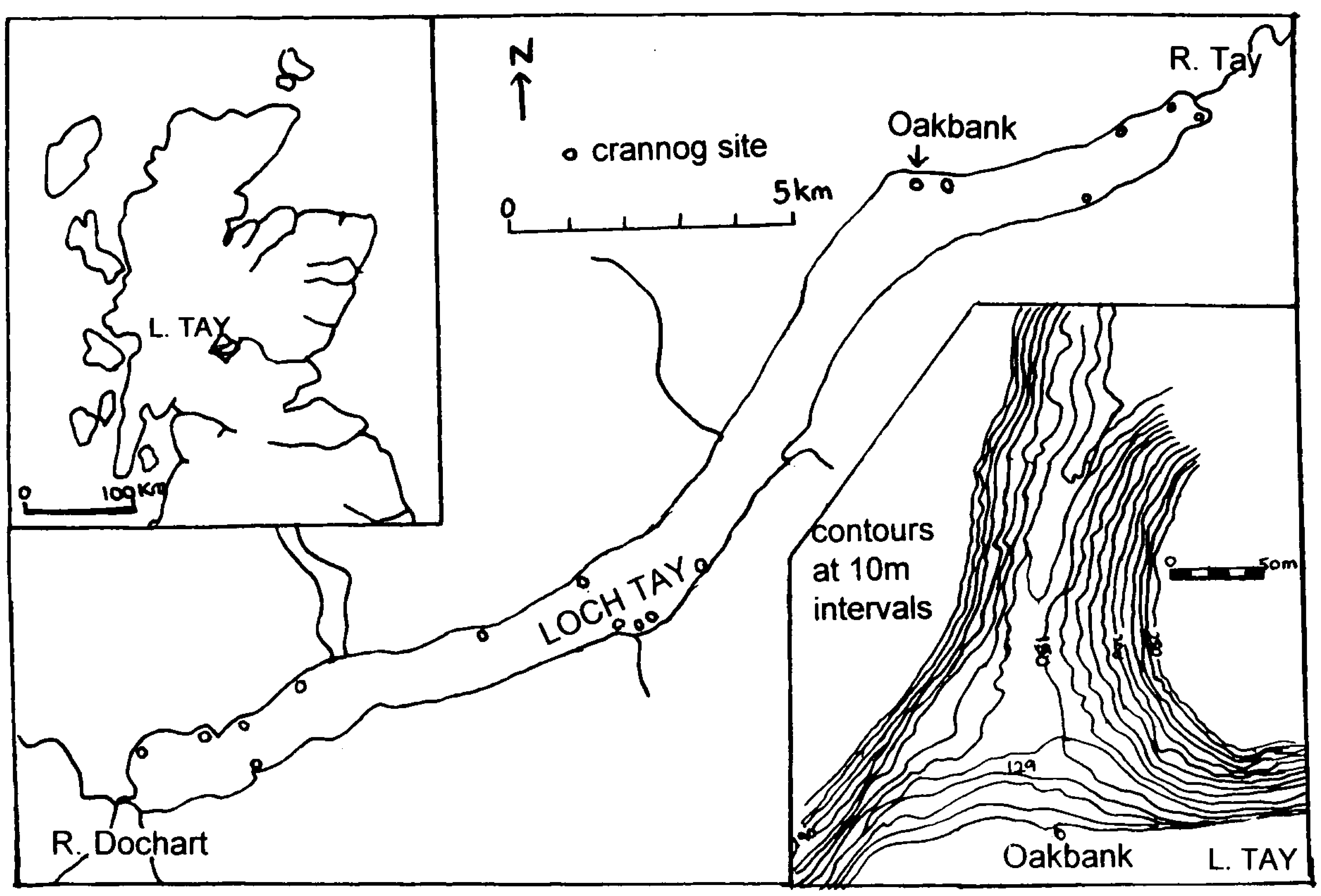

Figure 1.2. Distribution of crannogs in Loch Tay (adapted from Dixon 1982b figure 2). The right inset shows potentially cultivatable land adjacent to the crannog.

A floor level persists in areas B3 and C2. Floor remains are also present in B4 and D4. No definite proof has yet emerged of a hearth, but scattered charcoal has been observed in many areas.

Differentiation of the Oakbank organic matrix into visible lenses can be distinct, but may only exist for short widths as each is very individual. Possibly catastrophic subsidence in antiquity has occurred in areas C1 and D1 (Dixon pers. comm.), and wave action on the outer exposed side during occupation has further complicated the stratigraphy. The plateau in the calibration curve during the later first millennium BC accounts for the large range in ages given for all the dates in figure 1.1. and means successive reconstruction phases cannot be accurately chronologically dated. With the exception of the small alder stakes mentioned above, all dates are from large structural timbers, a number of which were oak (Sands 1994), further complicating the issue due to the longevity of this tree. Unfortunately oak dendrochronology was not possible here, but Crone (1988) did achieve a relative chronology from alder on the site, although this was insufficient to date the phases. Similarly, it not possible to tie samples taken for this project to the dated structural timbers as they were not in immediate association with them. Recent discoveries reported by Sands (1994) include a line of pile tips at 90^0 to the causeway piles buried under half a metre of silt and a scatter of pile tips beyond the furthest extent of the boulders in deep water. These reflect further aspects of occupation and emphasise the protective value of the boulder layer in preserving the site. Further archaeological details about positioning of piles and structures on Oakbank are recorded by Dixon (1984b) and Sands (1994).

Sands (1994) identified many piles during his analyses of tool marks on constructional timbers at Oakbank. He found that 51% of the total were alder, including most of the uprights and many horizontals. Oak was often used too, and also accounted for most of the 40 walkway piles (Dixon 1984b). Elm formed only 2% of the uprights and 3% were willow (Sands 1994), suggesting casual rather than selective incorporation. The frequent hazel wood Sands observed was in the form of round wood for hurdles. One fragment from A2 retained the only evidence of daub from the whole site. Rosaceae wood was

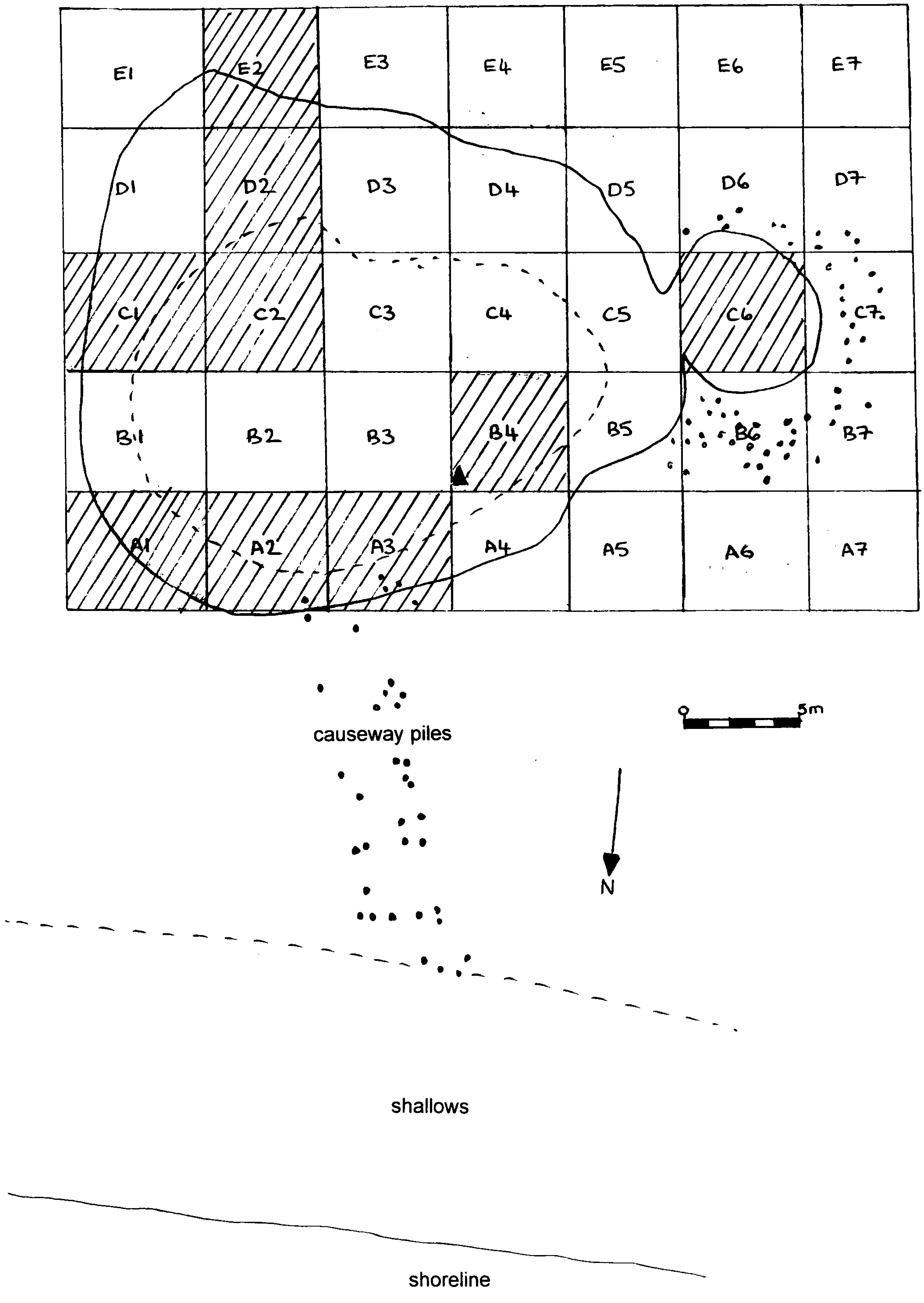

Figure 1.3. Site plan of Oakbank crannog. Areas sampled for this study are shaded. ▲ denotes position of Clapham & Scaife core. • denotes piles. Plan adapted from Dixon (1982b figure 4).

infrequent and in the form of small carved items. Pine was present as charred firelighting tapers and one waste chip which may indicate further unknown uses. The evidence Sands produced concurs with this study (see chapter 6).

Artefacts noted during excavations are varied and numerous (Dixon 1984b), including wooden bowls, pins, pegs, an ard, butter dish, canoe paddle and whistle. These are discussed in chapter 6. Coarse clay potsherds, stone spindle whorls and decorative beads were also found, but no metal other than iron stains remain. However, axe marks studied by Sands (1994) do give evidence of iron working, as does iron slag noted by Dixon (1984b) and this author. No bronze implements have been found, and non-metallic artefacts are not indicative of either the Bronze or Iron Age. Animal bone is also poorly represented, but include sheep/goats, pigs and cattle. No fish bone has been recognised, but it is expected that pike, bream, roach, trout and salmon would have been available as they are today. The copious organic detritus excavated by Dixon's team highlighted the potential for plant macrofossil analyses.

Previous Archaeobotany. Stokes reported in a very minor way on seeds from Oakbank as an appendix in Dixon (1984b). Her results are shown in the comparative table 8.1., as are the more detailed studies of Hansson (1988) and Clapham & Scaife (1988). Hansson studied only one sample for macrofossils from an unspecified central location, and consequently found a moderate number of taxa from woodland, grassland, ruderal and arable habitats, as well as food species including barley, gathered wild fruit and hazel nuts. However, Clapham & Scaife's contribution was much more substantial. They studied a core from B4 (figure 1.3.) from which pollen and macrofossil samples were taken. The benefit of this type of core is in the stratified, temporal sequence of events disclosed, but the drawback is that only one small location of the site is analysed. Clearly a combination of spot sampling and coring is most beneficial, as discussed in chapter 8. Figure 8.2 shows the pollen results obtained during the core study. Scaife's pollen diagram has disclosed evidence of a tree cover with *Alnus, Betula, Quercus, Corylus* and some *Ulmus*. Herb evidence comes from ruderals such as *Ranunculus, Plantago, Artemisia* and *Taraxacum* type, and agriculture is indicated by high cereal pollen and associated weeds. Although the core is stratified, it cannot reflect regional change in the way that a peat core can, because a not readily quantifiable but undoubtedly large component of the pollen would have been incorporated with selectively gathered plants from various sources. Nevertheless it remains as a sound basis for this study to elaborate upon. The same is true with even greater force for Clapham's macrofossil study from the same core. He produced a list of some 63 taxa from 8 samples, many of which are native species from various habitats including woodland, grassland, wetland, and arable ground. He also recognised cereals including barley, emmer and spelt wheat (the earliest in Scottish prehistory), as well as flax, gathered wild fruits and nuts.

Clapham & Scaife suggested possible reasons for the incorporation of the macro and microfossils found, ranging from crop processing and fodder to bedding and/or thatch. Their conclusions are plausible, but the localised nature and small diameter of the core cannot substantiate their theories in the way that a more widespread study could. For comparison of results see chapter 8.

1.6. Aims of this Project

It is the purpose of this study to enlarge upon the data produced by previous archaeobotanists by sampling various areas of the site. This will establish a sounder basis for deductions concerning the utilisation of wild and cultivated plants by the Oakbank inhabitants, enabling more informed judgements to be made regarding the habitats and wild communities exploited, as well as the types and relative abundances of the crops grown. In addition to this principal thrust of the work, it is hoped that the study will reveal areas reserved for specific activities within the dwelling and possibly give an indication of the social status of the inhabitants of the crannog.

PAGE
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Figure 1.4. shows the reconstruction of a free-standing pile platform, and figure 1.5. the completed structure. The construction has greatly benefited the understanding of the Oakbank structure by posing and suggesting answers for many questions about ancient building techniques. The author helped in a small way with this reconstruction and found it most informative. The reconstruction differs from the original in being thatched with *Phragmites* (reed) for economic reasons. Oakbank is not thought to have been thatched with this species, since no evidence of stems or seeds were found. Bracken is much more plausible here as phenomenal quantities covered all parts of the site. The educational value of such a structure to the public is also important, as Ruoff (1992) observed about the Pfahlbauland exhibition, a reconstruction of an Early Bronze Age lake-side village.

CHAPTER 2: MATERIALS AND METHODS

2.1. Underwater Sampling Strategy

The partial underwater excavation of Oakbank crannog during the summers of 1987, 1990 and 1991 led by Dr. T.N. Dixon of Edinburgh University Archaeology Department, provided organic samples suitable for botanical macrofossil analysis (see figure 2.1.). The archaeological excavation techniques employed are laid out in Dixon (1984b), and are similar to those employed in the Swiss and French lake settlements of Lake Neuchâtel (Ruoff 1980, Egloff 1987), Lakes Zurich and Greifen (Ruoff 1987) and Les Baineurs (Bocquet *et al.* 1987). The samples were taken from various locations on the site during the excavation, to allow an overall view of the most botanically interesting areas to emerge. For reasons of practicality and economic constraint the site has been excavated in stages over a few successive summers and still only 25% has been fully explored (Sands 1994). Each initial excavation period required the removal of large boulders from the surface of the excavation area, which were subsequently replaced at the end of the study, thus minimising contamination over the winter months.

Samples for botanical evaluation consisted mainly of 2 litre plastic containers which were either pushed into the matrix in a similar manner to the way that peat faces are box sampled, or filled manually. These containers were mostly ½ to ¾ full, filled to the top with loch water. Samples were coded according to their year of collection, site area code, and sample number. Context descriptions for samples were noted where appropriate. All samples were then stored in a cool room at Edinburgh University underwater archaeology unit with no further treatment until this project commenced.

The factors influencing the samples' individual collections were somewhat arbitrary, due to the unusual circumstances and the complicated nature of the site stratigraphy. Differences in matrix stratigraphy and individually interesting events were recorded where appropriate, but the sheer volume of organic remains (see figure 2.2.) means that more selectivity was required than was perhaps desirable.

Figure 1.4. Reconstructing a free-standing pile platform crannog in Loch Tay

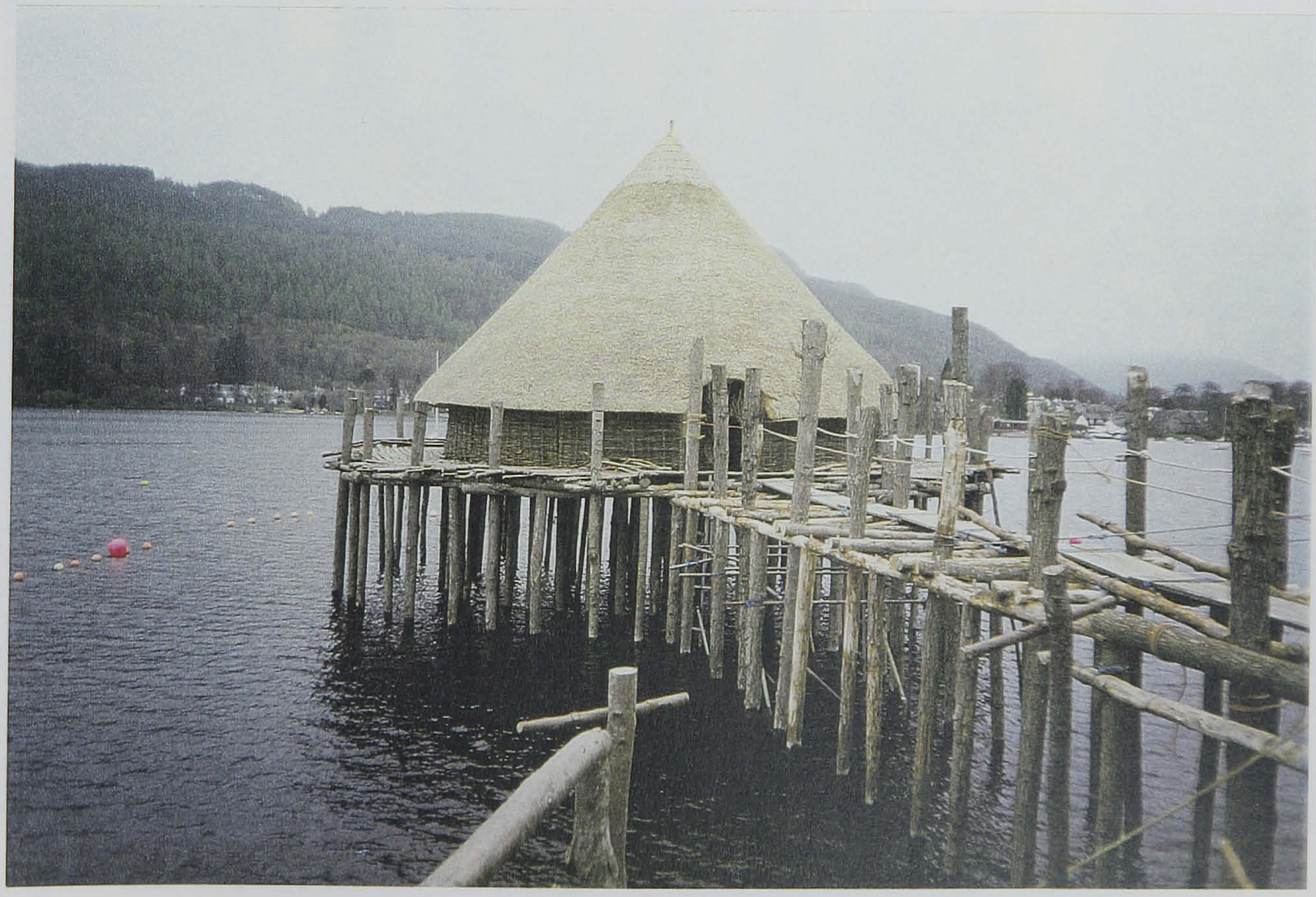


Figure 1.5. Completed crannog construction at Kenmore, Loch Tay

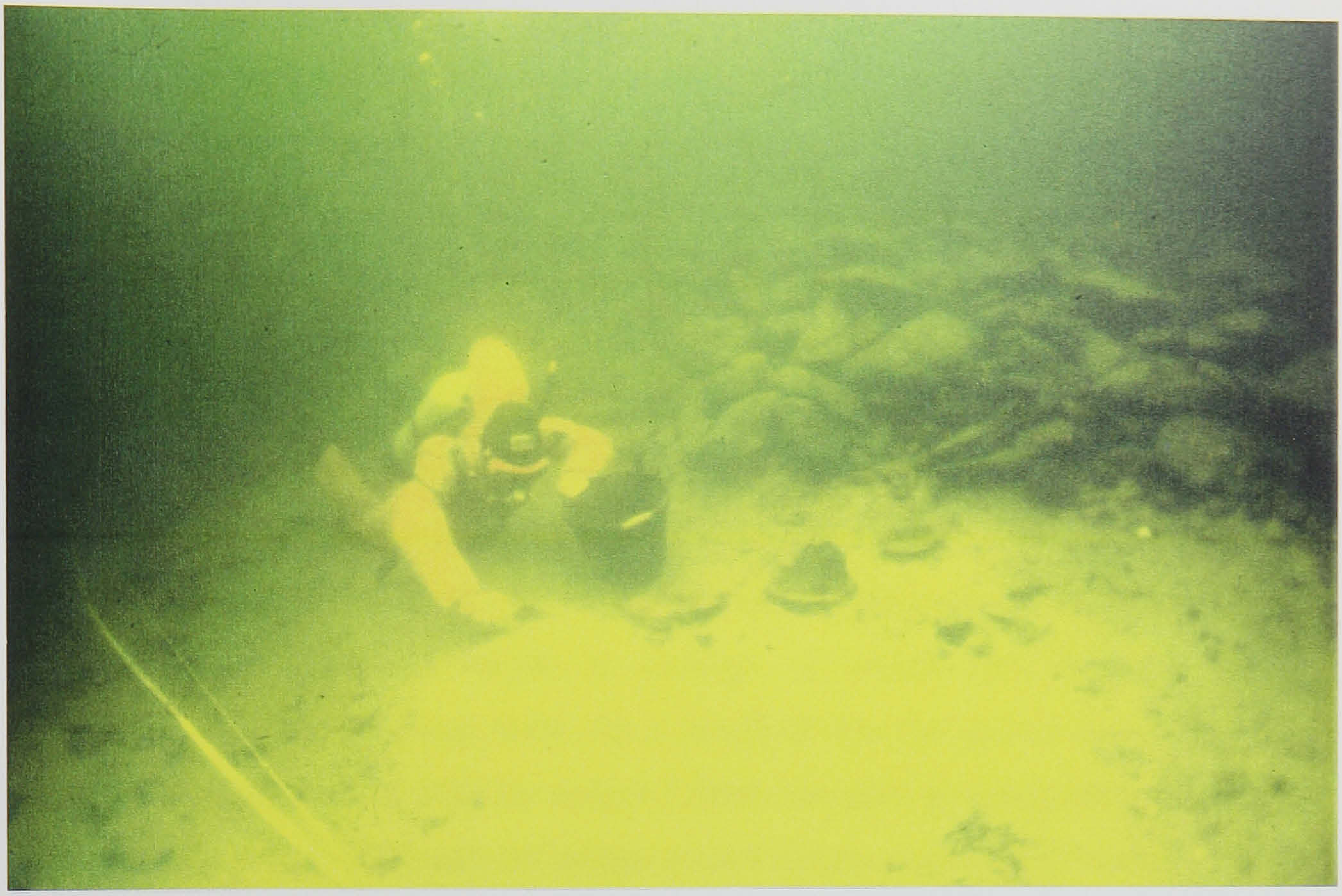


Figure 2.1. Diver beside the boulder-capped mound of Oakbank crannog (photo B. Andrian)

Figure 2.2. Exposed organic surface at Oakbank crannog (photo B. Andrian)

Facilities for bulk sieving waterlogged plant macrofossil remains on the site such as those at Les Baineurs (Bocquet *et al.* 1987) were not available, and as a result of this a great deal of the botanically interesting organic matrix was lost during the excavation. Nevertheless each sample examined in the laboratory was extremely macrofossil rich, allowing a comprehensive picture of the human influenced local environment and the economy of this Late Bronze/Early Iron Age site to emerge. All samples selected for this study were moved to Glasgow University in the autumn of 1993 and stored in a cold room at 2^0C until they could be individually examined.

Following detailed study of the samples obtained by the Edinburgh archaeologists a pattern began to emerge of areas disclosing the most interesting archaeobotanical finds. As a result of this the author dived with Dr Dixon in the summer of 1994 to collect further samples for analysis from these important localities. This was not in the course of any excavation, however, and sampling strategy was subsequently limited by accessibility of areas within the desired locations.

Excavating an archaeological site underwater has intrinsic difficulties and problems, but there are several invaluable benefits to be derived from it too. The buoyancy of water means that the site does not suffer the effects of compression of drained sites such as reported at Buiston and Lochlee (Munro 1882). The water also assists in excavation since a single diver can easily lift and move far greater loads than on land. The cold, oligotrophic water has maintained an excellent state of preservation overall, and is deep enough not to be subject to much wave activity while still allowing natural daylight to illuminate the site. The effect of distortion of light going through two media, i.e. water and the air within a diver's mask, is such that objects appear $^1/_3$ bigger than life. This is extremely beneficial in any archaeological site, but especially one with other intrinsic complications such as Oakbank crannog.

2.2. Laboratory Sub-sampling Strategies

Each sample underwent a visual description within its container before any work was done. The great majority consisted almost entirely of organic detritus, to such an extent that sub-sampling was a necessity. The only exception to this was when a single event had been sampled on site, for example the collections of nuts and fruitstones picked up in 90A1/2GEN. In these cases the entire sample was analysed.

200ml. displaced volume was taken as a standard sub-sample. Exceptions to this rule were made as necessary, especially in situations where the sample had a small initial volume or consisted of a high proportion of large diameter wood. Occasions where such exceptions were made are noted in the relevant sample results. The samples disaggregated satisfactorily in water in the majority of cases, although some required assistance from mounted needles under low power microscopy.

One preliminary attempt to disaggregate a sample using 5% NaOH resulted in droppings contained within the matrix disintegrating and the water turning dark and opaque. This happened even when the material was repeatedly rinsed in tap water. When the droppings were removed and isolated in clean water the reaction with the surface detritus continued and the droppings slowly disaggregated over the following few weeks. Changing the container water did not prevent this reaction. It was suspected that fine, amorphous detritus from both the organic matrix and the surface of the droppings was breaking down in an accelerated degradation. As this cloudiness inhibited low power observation of the matrix, it was decided not to use NaOH in further samples, even though it is standard practice in some laboratories. Clapham & Scaife (1988) used hydrogen peroxide to disaggregate samples, but it was thought that the bleaching effect of this chemical would be detrimental to the preservation of sensitive organic remains, and was not necessary anyway.

The sub-samples were sieved in the normal manner through a series of 500μm and 125μm sieves, with a basal tray below to catch silt. Separated fractions were initially examined under low power microscopy, and the matrix relative abundances described using the criteria of Hubbard and Clapham (1992). Following this the 500μm fraction was closely examined in water under low power microscopy and all identifiable macrofossil remains removed for identification.

During separation and identification in the laboratory, preservation of individual macrofossils not intended for AMS dating was initially achieved using thymol crystals in water. The effect of thymol is to inhibit fungal growth, apparently by preventing germination of spores, as established fungal growth is not inhibited. This may be achieved by the formation of a barrier film over the surface of the water through which airborne spores cannot penetrate.

Following specific identification, all wet plant remains not intended for AMS dating were stored in a mixture of 200ml. glycerol, 400ml. ethanol and 6ml. formalin. Well preserved seeds of robust species whose identification relies on close examination of the testa cell pattern under high power microscopy were dried to a barely damp condition and examined at X200 using the reflected light of a Zenith metallurgical microscope. Identifiable translucent and fragile macrofossils are preserved on normal or cavity slides. The mounting medium used initially was Aquamount, which has served effectively in this laboratory for many years. Unfortunately the formulation of this has been changed and it is no longer suitable for mounting anything at other than the merest film of depth. As this situation was entirely unsuitable, other possibilities were examined, and glycerine jelly was eventually found to be a satisfactory and relatively safe storage medium which can be used at enough thickness to retain small seeds.

The mounting methods for glycerine jelly are somewhat involved, requiring the melting and re-melting of very quickly-solidifying jelly. The benefit of this process is that it allows for the accurate positioning of small fossils on the surface of the just-set jelly, however. This can then be slowly melted just enough for a coverslip to stay on, and with practice the seeds do not move too far from their intended positions.

Two seeds intended for AMS dating were dried quickly in a covered container in a small low temperature oven before storage in a glass tube. These seeds were not in contact with chemicals of any kind during separation and identification.

Moss fragments were treated in the same manner as wet seeds. Remains were stored in glycerol, ethanol and formalin for examination and sorting using low power microscopy. Single leaves of *Sphagnum* species were mounted on a slide in glycerine jelly.

The 125μm fraction from any sample was treated somewhat differently to the coarser one, in that it was settled in a measuring column and its displaced volume noted. A measured, variable, sub-sample of this was then taken, from which the plant remains were carefully removed and identified (Körber-Grohne *et al.* 1983). This measure was taken as the numbers of *Juncus* species seeds in some samples were excessively high. An indication of the approximate number of *Juncus* seeds could thereby be calculated by extrapolation. Following this the rest of the 125μm fraction was then scanned to account for any different species. All selected *Juncus* species seeds and other small macrofossils requiring testa cell recognition were placed on slides in the manner described above.

2.3. Sub-fossil Recognition Aids

Identification of seeds was initially by reference to the texts of Beijerinck (1947), Nielsson & Hjelmqvist (1967), Berggren (1969 & 1981), Körber-Grohne (1964 & 1991), Schoch, Pawlik & Schweingruber (1988) and the extensive reference collection of Glasgow University. Identification of cell layers visible in many edible species came from Winton (1916) and Winton & Winton (1945). Wood and charcoal were recognised with the assistance of photographs and descriptions by Schweingruber (1982 & 1990), and Jane (1970). Buds followed Tomlinson's (1985) Guide. Jacomet (1987) and Hillman's unpublished undergraduate teaching notes were referred to for cereal chaff identification. Identification of mosses came from Watson (1981) and Dr. J.H. Dickson of Glasgow University. Pollen identification was by reference to Moore *et al.* (1991) and the Glasgow University slide collection. Stace (1991) nomenclature is used for wild taxa discovered, with Clapham *et al.* (1987) followed for aggregate species. Cereal nomenclature follows Renfrew (1973) but reference is drawn from Zohary & Hopf (1993).

Photographs of subfossils in this text were taken using the best equipment available, but are not always as clear as might be desired. Repetition using different film speeds and lighting arrangements had no effect on results obtained, and apologies are made in advance for poor quality. The reader is advised that sizes are given in the text for all macrofossils photographed, and that photos are not to scale.

CHAPTER 3: IDENTIFICATION TECHNIQUES

Identification to species level of seeds of problematic and difficult genera is very important for a holistic approach to the understanding of environmental conditions around an archaeological site. In view of this the author identified to species all well preserved fruits of the small Poaceae and the genus *Carex* from Oakbank crannog. This chapter deals with identification techniques used to separate these individual species, gives criteria used to distinguish the various waterlogged cereal caryopses and chaff, and describes rare finds and unusual observations from the study. Descriptions follow in alphabetical family order.

3.1. Identification of *Torilis japonica* (Upright Hedge-parsley, Apiaceae)

Fruits of the Apiaceae family are plano-convex carpels joined in pairs on the commisural (inner, flattened) side (Winton 1916). Apiaceae carpels are easily recognisable by their possession of ribs on the convex dorsal side. Five primary ribs and sometimes four secondary ribs are located here (Winton 1916). The shape of these and the ornamentation of the overlying epicarp, which can be smooth or with uni- or multi-cellular hairs aids initial identification of fruits of a similar size. Underneath the epicarp runs a two layered mesocarp composed of outer and inner parenchyma. Running longitudinally between these layers and alternating with the ribs are ducts (vittae) containing brown essential oil. It is for these aromatic oils that the Apiaceae are so important for flavourings and medicinal purposes.

Few Apiaceae fruits were recovered from the Oakbank assemblage, all as single carpels. These included *Heracleum sphondylium*, which has a large and easily recognisable fruit, and *Torilis japonica*. This latter ought to be easily recognisable too, since the fruit is covered in long, recurved spines. However, the Oakbank macrofossils of this species had lost these spines to a greater or lesser degree, and one had lost them so completely that it had the general appearance of *Petroselinum crispum* (parsley). This was the first *Torilis* species macrofossil found on the site and initially was not recognised as a hedge-parsley due to its complete lack of spines.

The indeterminate macrofossil was compared with artificially fossilised modern reference material of many Apiaceae fruits. Details were observed using recent reference material which had been boiled in dilute NaOH. The seeds for comparison included parsley, whorled caraway (*Carum verticillatum*) and corn parsley (*Petroselinum segetum*). These were all superficially similar to each other, but were different enough at cellular level to permit satisfactory separation. Features used in the separation of these fruits related to the dimensions and features of the vittae, including the width, number of pericarp cells superimposing the vittae, and the thickness of the mesocarp parenchyma. Using these criteria it was possible to separate the poorly preserved Oakbank macrofossil from *Carum verticillatum* and *Petroselinum segetum,* but not from *P. crispum.* There was found to be almost no variation between the indeterminate macrofossil and garden parsley using these criteria, although the unidentified fruit was slightly larger and not as rounded as the parsley. As many Apiaceae carpels are produced in each flowering episode, it is clear that slight differences in shape and size will be normal. Consequently this alone will not permit adequate identification.

As no other artificially fossilised Apiaceae fruits compared so well to the unidentified fruit as parsley, the fossil was initially suspected to be this, although this would have been most remarkable. It was only when several other fossil *Torilis japonica* fruits were recovered together in better condition to various degrees, that close comparison revealed the indeterminate seed was a *Torilis* species, put as *T. cf japonica.* It should be noted here that artificially fossilised modern *Torilis japonica* retained their spines until the fruits fell apart. The identification of the indeterminate fossil, completely lacking in spines apart from one vestige, could not have been achieved using only artificially fossilised modern material. Specific conditions at Oakbank crannog may have resulted in this peculiar type of preservation.

Similarity in morphology between poorly preserved individuals of hedge-parsley and garden parsley seed (see figure 3.1.) has implications for the parsley recovered from Roman Silchester (Reid 1905), which was not described in the text. Parsley is thought to be a medieval import and its presence in a Roman site is most interesting. If verified it implies Roman importation, but the question of whether it was used as seed or cultivated for leaves remains unanswered. Unfortunately Silchester museum has not yet been able to locate this material to compare with the Oakbank fruit.

3.2. Identification of *Carex* Species Nutlets (Sedges, Cyperaceae)

Carex species nutlets generally preserve well and are often found in archaeological deposits. Until fairly recently it has been common practice to identify them to generic level only, as the nutlets can be extremely similar, and some hybridise (e.g. *C. viridula s.l.*). This was deemed acceptable under the assumption that the majority are damp/wet grassland indicators to a greater or lesser degree. However, this wide generalisation does not take into consideration the nutrient status of the soil which can be suggested by the fossil assemblage, such that specific identification is essential for any phytosociological study.

From an archaeobotanical perspective, the robust *Carex* nutlets are often one of the few fossil indicators remaining from turf used for wall and roof insulation or fuel. It is clear that various turf assemblages will give distinct properties, and hence be used for different purposes (Fenton 1978). Specifically, the fibrous nature of turves thinly cut from peaty areas gives a dense, strong, and long-lived base on which to lay thatch, whereas those cut from grassy areas are more suitable for a "growing roof" apex. The reconstructed roof of the 18th century cottage 'Old Leanach' at Drumossie moor, Culloden, Inverness-shire shows sedge turf apex over a *Calluna vulgaris* thatch (figure 3.2.). However, turves are usually cut from low growing vegetation, which often limits the number of species likely to be found. Some species are more common e.g. *Carex flacca*, but others are frequently found only in specific types of plant communities and are subsequently more diagnostic of habitat (e.g. *Carex sylvatica*).

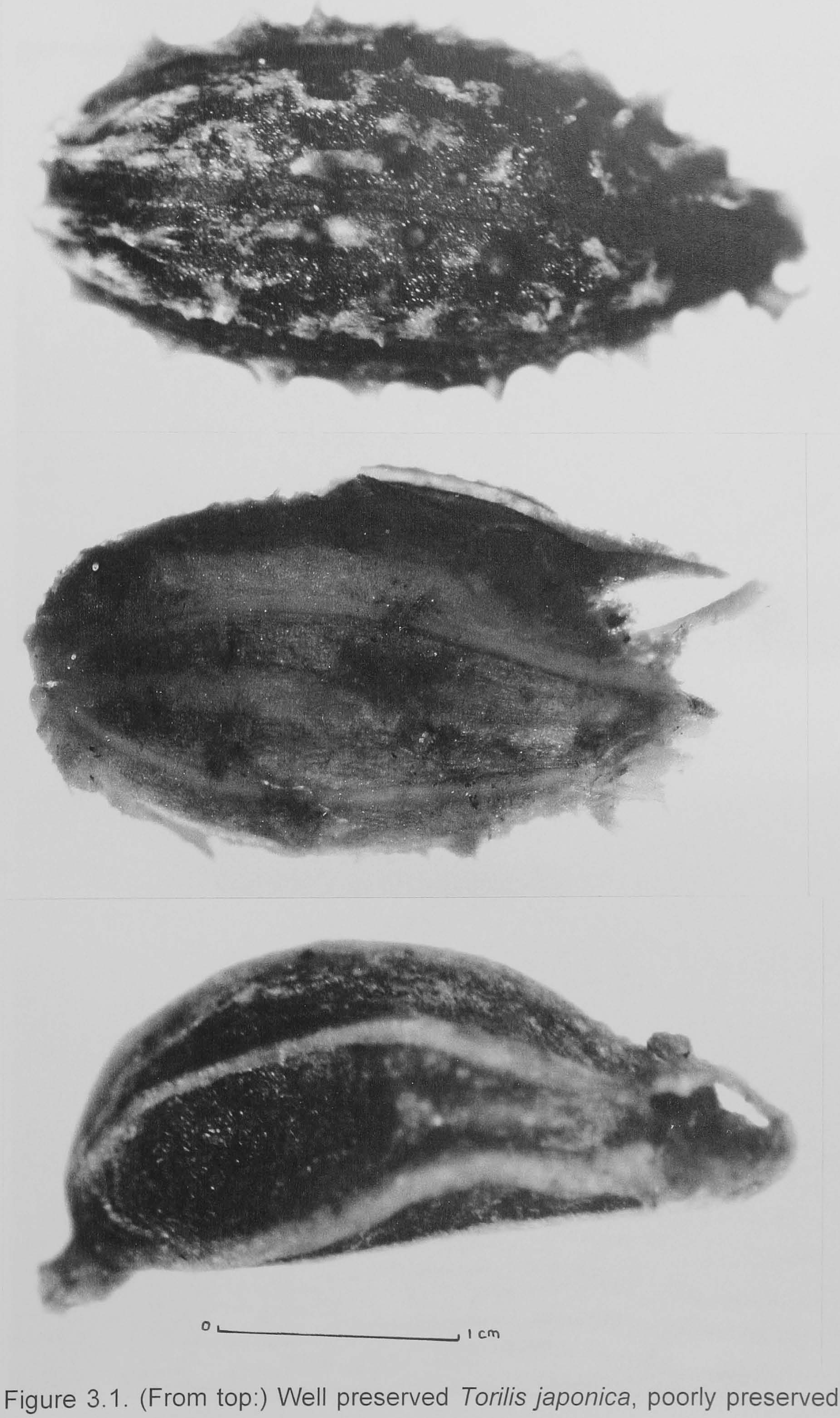


Figure 3.1. (From top:) Well preserved *Torilis japonica*, poorly preserved *T. cf. japonica* (both Oakbank), modern *Petroselinum crispum*

Figure 3.2. 'Old Leanach' cottage, Drumossie Moor, Inverness, with turf apex over *Calluna vulgaris* thatch

3.2.1. *Carex* Identification Criteria

Specific identification of *Carex* nutlets from Oakbank crannog was initially by comparison with the Glasgow University seed reference collection at low power. Subsequently, examination with a Zenith metallurgical microscope with reflected light at X200 magnification aided comparison of similar species' cell patterns. Close reference was made to the key and drawings in Nilsson & Hjelmqvist (1967) and photographs and descriptions in Berggren (1969).

Seed morphology is very stable and little affected by external influences, such that individual characteristics can be depended on for diagnosis. Minor variations caused by immaturity or degradation must be considered, but a well preserved mature nutlet can usually be identified accurately. Hybridisation is a phenomenon which must also be considered in some species, but in general a nutlet with the characteristic shape, size and cell pattern of a particular species can be unequivocally identified. Individual variations to this rule will be discussed in the text.

Carex nutlets are initially sorted by shape, being either trigonous or biconvex. Following this, measurement is taken from the base of the stipe (attachment point for the fruit stalk) to the summit of the nutlet, not including the persistent style base which is frequently absent in a degraded fossil. These two characters will put the nutlet in question to within a narrow range of possibilities.

Characters useful in identification of species subsequent to this initial sorting are as follows:

Shape: The nutlet may be elliptic, ovate, obovate, lanceolate or trullate with width variations on each theme. Some species have a range of forms. Berggren (1969) has drawings of the Northwest European species' shapes at the back of her atlas. Within these shapes the nutlet may taper gently or abruptly to the style at the summit, and similarly at the base.

Angles: The angles on trigonous nutlets may be obtuse or acute and (often) pale yellow coloured. Angles may be more obvious at the base of the nutlet as in *C. pilulifera*, or wide and ill defined near the summit, especially in the wider obovate trigonous species such as *C. rostrata* and *C. hostiana*. In biconvex nutlets the edges may be rounded or relatively sharp.

Colour: Nutlet colour is not necessarily diagnostic in the fossilised condition, as external influences play an important part in determining preservation. Nevertheless the various species tend towards certain colours, which assists in identification with experience. A colour chart for modern nutlets is published in Berggren (1969).

Faces: These may be convex, flattened, or concave. In biconvex nutlets there may be a variation between the outer and inner faces (e.g. *C. echinata*). In these cases the inner face is usually flattened or slightly concave, with the other one relatively convex, either entirely so, or at the base. In trigonous nutlets the situation is more complicated, and achenes may be convex at the top and flattened or concave at the base of the same face. (e.g. *C. panicea)*.

Stipe: The width of the stipe and presence or not of scar callus aids identification.

Style: The width of the style base or stylopodium (swollen style base) is characteristic.

Epidermis: The nutlets may or may not have a silver-grey outer epidermis which is distinctive. In the dry state and under X200 magnification, some species have indistinct cells, where the diameter is in fact the reflective part the lumen, but others have distinct and measurable walls. Those species which are less obvious are covered with a layer of "varnish", which is not seen in the fossilised state. Modern reference nutlets may be "fossilised" by heating in 1% NaOH for several minutes before comparison in these cases. The basic cell shape for *Carex* spp. is ± hexagonal with thick or thin walls, raised or sunken, if distinct. Immature cells may be flat but mature cells are most commonly papillate or verrucose. The size of the papillae is a useful distinguishing characteristic when all but the most closely similar species have been eliminated (e.g. *C. ovalis* and *C. disticha*). Papillae may be low and flat or pointed, and range from very small to large and almost verrucose. Figure 3.3. demonstrates this range. It must be remembered that papillae do degrade, however, and careful focusing is necessary to ensure that small papillae are not in fact remnants of larger ones. A faint circle around the base of the papillae is seen in these cases. Verrucose cells do not have a distinct width of wall, but may have a wavy margin as in *C.*

echinata. In the fossil condition the outer epidermis may detach from the inner one and in these cases a verrucose nutlet may expose a layer with, for example, small papillae as in *C. disticha*. However, these inner epidermal cells are readily identifiable as such, as they are flat and have a granular appearance. Further degradation will expose the longitudinal fibres and the cell pattern cannot be used for identification if this state of preservation is present.

3.2.2. Identification of *Carex* Nutlets from Oakbank Deposits

The nutlet descriptions which follow and the methods employed to separate them from other types are for those species found at Oakbank. Nomenclature follows Stace (1991) for most recent terminology. Previous names employed by Berggren and Nilsson & Hjelmqvist are given in brackets to assist cross-reference. Size limitations for both texts are given, as they do not entirely agree. This is thought to reflect differences in the populations studied. Those given by Berggren (B) are in italics, with Nilsson & Hjelmqvist (N & H) in normal text. In most cases these authors are in relatively close agreement, but major discrepancies are noted. The Oakbank (OB) fossil ranges and number of nutlets they apply to are given in bold type. Only positive identifications are included. Table 3.1. shows the number of each species found in individual samples at Oakbank. Representative fossil nutlets of each species are shown in figures 3.4. (biconvex) and 3.5. (trigonous).

<u>3.2.2.a. Separation of biconvex spp: *C. ovalis, C. disticha, C. echinata, C. nigra*</u>

<u>*C. ovalis*</u> (*C. leporina*): Oval sedge. Faces are elliptic-oblong, occasionally ovate-oblong.

(B) *1.4-1.7mm x 0.8-1.0 mm*

(N & H) 1.6-1.8mm x 1.0-1.3mm

(OB) 1.4-1.8 x 0.8-1.1mm, 31 nutlets

The orange-brown colour and lustrous surface of faces may appear grey-white in fossil if the outer epidermis has separated from the inner one. The inner face is flattened, whereas the outer has a faint central ridge, making it partly convex.

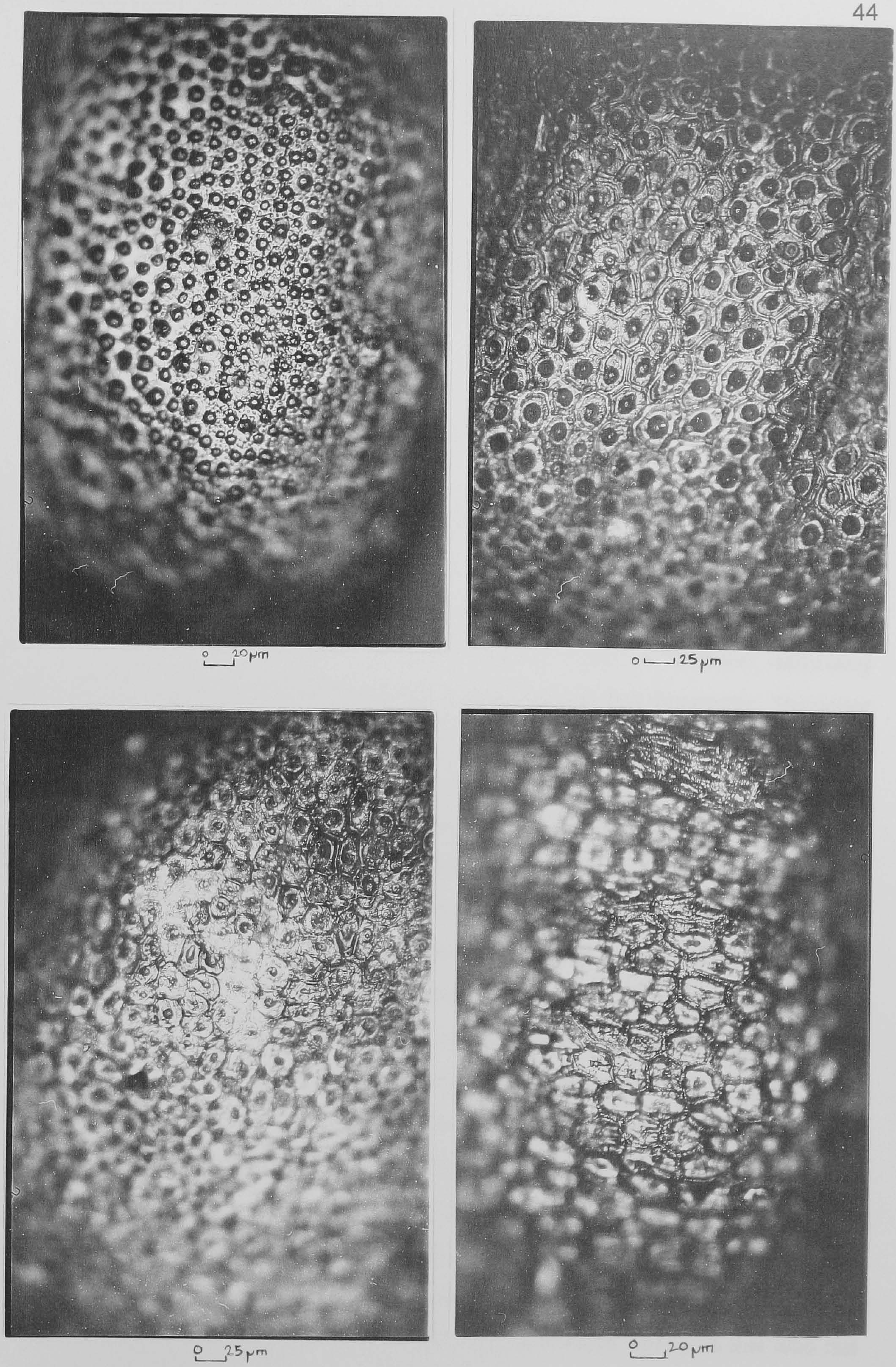


Figure 3.3. Variation in the shapes and sizes of *Carex* spp nutlets (photos N. Tait). Top left: *C. ovalis* small-medium, low. *C. binervis* medium-large, pointed. Bottom left: *C. nigra* small pointed & broad low. *C. flacca* very small pointed

The stipe is 0.2mm wide x 0.2mm long. The style base is slender. Cells of the epidermis are uniformly hexagonal 19-25μm, with distinctive medium rounded papillae of similar size.

C. distincha: Brown sedge. Faces are elliptic to ovate.

(B) *1.6-2.0mm x 1.0-1.3mm*

(N & H) 1.5-2.2mm long

(OB) 1.5-2.0mm x 1.0-1.2mm, 27 nutlets

The brown colour of the nutlet is generally darker than *C. ovalis*, unless degraded. The surface is lustrous and may appear grey-white as in *C. ovalis*. The inner face is flattened, with the outer one slightly convex, asymmetrically. The stipe is 0.25mm wide x 0.15mm long. The style base is slender. Outer epidermis cells are verrucose, with ± wavy cell margins. Cells are rounded oblong, with variation in size and shape. The cell length is 19-45μm, narrowing towards the stipe. Outer cells may be longer, but are not diagnostic. The inner epidermis, if exposed through abrasion, is finely papillate. Margins are rounded.

Carex ovalis, C. disticha and *C. arenaria* are closely similar in shape and size. *C. disticha* is generally slightly broader and more ovate than *C. ovalis*, however, and tends to be over 1.05mm wide, whereas *C. ovalis* is generally under 1.1mm wide. In transverse section *C. ovalis* is symmetrically convex to a central peak, whereas *C. disticha* is asymmetrically inflated. The stipe of *C. ovalis* is narrower than the other two species, and the style base more persistent. In shape, *C. ovalis* is more usually elliptic/ovate-oblong, whereas *C. disticha* is frequently more ovate, and a larger nutlet altogether. *C. arenaria* is shaped like *C. disticha* and has a similar size, but is obviously convex on both faces, and has a broader, distinct stipe. *C. arenaria* is a dark brown-black colour if well preserved. The papillate epidermal surface of *C. ovalis* is distinct even if somewhat degraded and can separate the species from the other two, both of which are verrucose. *C. arenaria* was not found at Oakbank. It is confined to coastal areas in Scotland (Perring & Walters 1976) so this was not unexpected.

C. echinata: Star sedge. The nutlet is trullate with rounded margins and edges.

(B) *1.5-1.9mm x 0.9-1.3mm*

(N & H) 1.4-2.1mm long

(OB) 1.7-2.2mm x 1.1-1.4mm, 8 nutlets

The nutlet tapers strongly towards the style base, and has a distinctly truncated stipe (0.2mm long x 0.2-0.25mm wide). The inner face is flattened, while the outer one may be convex towards the base The epidermis is lustrous, and olive-brown or brown. The cell pattern is verrucose with tiny papillae sometimes visible on the inner epidermis.

C. echinata is only closely similar in shape and size to *C. paniculata*. Separation of the two is primarily by the degree of convergence towards the style base which is much more marked in *C. echinata*. *C. paniculata* has blunt shoulders and tapers from the centre of the nutlet down to the stipe such that the widest part is towards the centre, whereas it is much lower in *C. echinata*. Also the inner face of *C. paniculata* is convex at the top, rather than flattened like *C. echinata*. *C paniculata* has medium, relatively low and obtuse papillae, whereas *C. echinata* is verrucose and may have tiny pointed papillae underneath.

C. nigra: Common sedge. In shape elliptic to sub-orbicular, broadest at or just above the centre.

(B) *1.5-2.0mm x 1.0-1.4mm*

(N & H) 1.4-1.8mm long

(OB) 1.7-2.0mm x 1.0-1.6mm, 10 nutlets

Edges of the faces are relatively sharp. Both are convex, and brown, with a barely lustrous surface. The style base is persistent and erect, 0.2-0.25mm wide. The stipe is always broad, *c.* 0.5mm wide. Epidermal cells are distinct, 20-25µm. diameter (Berggren 1969). Cells have medium to large broad, low papillae, but there may also be small pointed ones on the same nutlet. It is a variable aggregate species but one whose wide nutlet base assists early diagnosis. *C. nigra* now encompasses *C. cespitosa* (Clapham *et al.* 1987). This last is treated as a separate species, *C. caespitosa*, by Nilsson & Hjelmqvist

(1967) and Berggren (1969). No mention of *C. caespitosa* is given in Stace (1991).

C. nigra belongs to Section Acutae (Fr.) but is most closely similar in terms of shape and size to *C. acuta* and *C. elata*. Many in the section are non-British species, but all with the exception of *C. paleacea* and *C. vacillans* (both non-British) have a short, obovate to orbicular nutlet with rounded margins and a narrow style base which tapers gently on to the nutlet, and a broad base. *C. elata* is separable by size at the top end of its range (1.6-2.5mm), and tends to be squarer at the top of the nutlet. (Nilsson & Hjelmqvist 1967). It also has small papillae. *C. acuta* is often more obovate than *C. nigra*, and with more rounded edges, and in this condition, separation is more easily facilitated. Cells of *C. acuta* are hexagonal to oblong, and with broad and low medium papillae, whereas *C. nigra* has hexagonal cells and may have small pointed papillae as well as broad, low ones on the same nutlet. Experience demonstrates the general "look" of *C. nigra*.

3.2.2.b. Separation of trigonous spp: *C. viridula s.l, C. flacca, C. rostrata, C. hostiana, C. pilulifera, C. panicea, C. sylvatica*

C. viridula s.l. encompasses three closely similar subspecies, until recently given specific status. These are as follows:

C. viridula ssp *viridula* (*C. serotina, C. oederi* ssp *pulchella* or ssp *oederi*). Small-fruited yellow sedge.

C. viridula ssp *oedocarpa (C. demissa, C. tumidicarpa).* Common yellow sedge.

C. viridula ssp *brachyrryncha* (*C. lepidocarpa).* Long-stalked yellow sedge.

All three have a similar nutlet with a distinct shape, but differences in size and cell pattern of the epidermis ensure that identification can be done, albeit tentatively in some circumstances. This is an aggregate species which hybridises freely, such that identification is not always possible to subspecies level.

C. viridula cf ssp *oedocarpa* was frequently found at Oakbank. The nutlets were described as follows:

C. viridula ssp *oedocarpa.* Common yellow sedge. Faces are cuneiform, widely obovate, and convex.

(B) *1.2-1.5mm x 0.9-1.2mm*

(N & H) 1.3-1.5mm x 1.0-1.1mm

(OB) 1.2-1.5mm x 0.8-1.1mm, 42 nutlets

Angle lines are sharp, distinct and a paler yellow colour than the three dark faces. The style base is small, *c.* 0.1mm long, and the stipe is 0.15mm wide with a persistent callus. The lumina of the epidermal cells are ± refractive, with medium and occasionally large papillae.

Separation of *C. viridula* ssp *oedocarpa* from *C. viridula* ssp *viridula* and *C. viridula* ssp *brachyrryncha* depends on nutlet size and papillae diameter. In both Berggren and Nilsson & Hjelmqvist there are two subspecies of *C. viridula* ssp *viridula* (then called *C. oederi*) noted, namely *C. oederi* ssp *oederi* and *C. oederi* ssp *pulchella*. Ssp *pulchella* is obviously smaller than ssp *oederi*, being 1.0-1.2mm x 0.8-0.9mm (N & H). This data is different in Berggren (*1.3-1.5mm x 0.8-1.1mm*) which is rather confusing. Ssp *oederi* is 1.2-1.5mm in N & H, but *1.1-1.6mm* in Berggren, again showing discrepancy. Fortunately these two subspecies are no longer recognised and this confusion can now be avoided. In the new *C. viridula ssp viridula* the size range is 1.0-1.2mm in reference nutlets examined. The papillae are medium, like ssp *oedocarpa.* However a nutlet at the lowest end of the size range can be confidently identified. *C. viridula* ssp *brachyrryncha* is generally larger than *C. viridula* ssp *oedocarpa*. (B) *1.4-2.0mm x 0.9-1.4mm,* (N & H) 1.4-1.6mm x 1.0-1.1mm. Faces taper, often slightly curving, towards the stipe, which may not be obvious. The style base is distinct and may curve. Angles are sub-edged and therefore less noticeable than in ssp *oedocarpa*. Cell lumina are ± highly reflective, and rarely refractive. Papillae are small and pointed. On the basis of size and shape a nutlet can be tentatively identified. If the cell pattern has survived then this can be done with confidence. *C. viridula s.l.* is in Sect. *Extensae* Fr. subsect. *Fulvellae* Ands., along with *C. flava*.

C. flava has a similar size to *C. viridula* ssp *oedocarpa,* but is more obovate than cuneiform, and tapers gently to the style base. Papillae are small to medium and pointed. This species was not found at Oakbank. *C. hostiana* is in Sect *Extensae* too, but in subsect. *Extensae*, which reflects its somewhat different shape. *C. hostiana* was frequently encountered at Oakbank, and can be readily identified by the combination of its shape and epidermal surface. Others within the section are distinctly more oval, and can be easily discounted.

C. hostiana: Tawny sedge. In shape elliptic to obovate. If elliptic, then this is of a relatively distinct shape. If obovate, and may be broadly so, then almost similar in shape to *C. panicea*, although smaller.

(B) *1.7-2.5mm x 1.3-2.0mm*

(N & H) 1.5-1.6 x 1.1-1.2mm

(*OB*) 1.7-2.0 x 1.1-1.3mm, 21 nutlets

Faces are slightly convex, with bluntly keeled angles. Angle lines are narrow and pale. Faces are brown, faintly lustrous, often with a grey outer coating. Style base is narrow, *c.* 0.15mm wide, but stands upright and usually persists even in degraded fossils. The flattened or gently sloping shoulders of the nutlet up to the style base are usually recognisable with practice. Conversely the stipe is indistinct and may not persist in any discernible form in the fossilised state. The majority of Oakbank nutlets were of the narrower, elliptic shape. Epidermal cells are distinct, with low, flat medium to large papillae, and may be ± verrucose. Cells under the grey outer epidermis have (small) to large pointed papillae.

C. hostiana is separated from *C. pilulifera*, which may have a similar shape, by the very narrow, yellow angles and orbicular shape of the latter. The elliptic obovate forms of *C. hostiana* are separated from *C. pallescens* by the latter having much narrower edges, which are pale yellow, and with a protrusive, upright style. *C. hostiana* can be so obtuse that it shows almost no edges at all. *C. pallescens* is also a buff colour, barely lustrous, and has small to medium pointed papillae on distinctly visible cells. Broadly obovate nutlets of *C. hostiana* can be separated from *C. panicea* and *C. rostrata* by size. These two are described in the text.

<u>C. pilulifera</u>: Pill sedge. Only one absolutely identified nutlet was found in Oakbank samples. The species is described as having broadly elliptic to almost obovate faces which are widely convex, giving an almost circular cross-section.

(B) *1.3-1.6mm x 1.1-1.3mm*

(N & H) 1.6-1.7mm x 1.2-1.3mm

(OB) 1.7mm x 1.1mm 1 nutlet

Faces are brown and lustrous with a partial grey outer coating. Papillae on this outer epidermis are small and pointed, being mostly large and flattened underneath. The angles on the nutlet are obtuse but narrow at the top, becoming broader towards the base. The style is straight or curved and may not persist, as in the case of this fossil. The stipe, if present, is indistinct and short. *C. pilulifera* can be separated from *C. ericetorum* by the latter being more oblong than oval, and dark brown and shiny. Angles are very narrow, only distinct towards the base. These are always distinct in *C. pilulifera*. *C. ericetorum* also has medium pointed papillae. Methods employed for separation of *C. pilulifera* from *C. hostiana* have been previously described.

<u>C. flacca</u>: Glaucous sedge. Faces are cuneiform, tapering to the base.

(B) *1.4-2.0mm x 1.0-1.3mm*

(N & H) 1.5-1.7mm x 1.2-1.3mm

(OB) 1.4 x 0.9mm, 1 nutlet

The stipe is obvious and has callus at the scar. Faces are flat to relatively concave. The style is erect or curved and persists in the fossilised condition. The epidermis is dull, lustreless, but with distinct, almost circular epidermal cells and minute, pointed papillae. On first impression this species has a similar appearance to *C. viridula s.l.* at the extreme lower end of the size range. The difference becomes apparent with closer examination, as the angles are blunter and wider, and the style base is bent.

<u>C. rostrata</u>: Bottle sedge. Obovate to elliptic, but tapering towards the base, and almost sessile. Conversely the style is thick, *c.* 0.2mm or more, and curved.

(B) *1.2-2.0mm x 1.0-1.5mm*

(N & H) 1.7-2.0mm x 1.1-1.5mm

(OB) 1.7-1.8mm x 1.1-1.5mm, 2 nutlets

Faces are brown, lustrous, and verrucose, flattened to slightly concave, and with somewhat acute angles which are broader and more distinct near the base than at the top.

C. rostrata is similar in shape and size range to *C. panicea, C. vesicaria, C. hostiana* (obovate types), and *C. flacca*. Separation is achieved by comparison of angle widths and epidermal surface patterns. The species is separated from *C. vesicaria* by the latter having small pointed papillae and indistinct angle lines. Furrows may be noticeable on the faces which are not found on *C. rostrata. C. flacca* is smaller, a brighter colour and with thicker angles and small papillae. *C. hostiana* is more elongate and although almost verrucose, does not have the general look of *C. rostrata. C. panicea* is most similar in shape, but is rather large and has medium to large papillae.

<u>*C. panicea*</u>: Carnation sedge. This species has large, distinctive nutlets which are broadly elliptic to obovate, and which taper gently towards the summit and base.

(B) *1.9-2.7mm x 1.3-1.8mm*

(N & H) 2.0-2.4mm x 1.5-1.8mm

(OB) 2.0-2.2mm x 1.1-1.7mm, 6 nutlets

The style is thick, pale, and persists in the fossil state. The base of the fossil is wide, (0.5-0.7mm) and sessile. Angles are obtuse and much paler than the dark brown faces. The epidermis may have a grey outer layer, giving a barely lustrous surface. Papillae are medium to large. A nutlet in the upper half of the size range cannot easily be confused with any other.

<u>*C. sylvatica*</u>: Wood sedge. Another relatively distinctive species, with only *C. vaginata* and *C. riparia* being of a similar size and shape.

(B) *2.0-2.8mm x 1.2-1.5mm*

(N & H) 2.6-2.7mm long

(OB) 2.0-2.8mm x 1.1-1.3mm, 7 nutlets

C. sylvatica has narrowly elliptic to oval faces and tapers to both summit and base. The faces are yellow brown and barely convex, becoming relatively concave at the base. Angles are obtuse but nevertheless obvious, somewhat smoothly rounded and pale. The style base is narrow but persistent, as is the stipe, which widens at the point of attachment to the plant. The faces of the nutlet are faintly lustrous, with medium pointed papillae. Nilsson & Hjelmqvist observed one face narrower than the other two. This was not obvious in Oakbank fossils, nor is it mentioned by Berggren. It may be a peculiarity of the populations studied by those authors.

C. sylvatica is separated from *C. vaginata* by the latter's broad, protrusive angle lines and minute pointed papillae. *C. riparia* differs from *C. sylvatica* by being somewhat oblong with distinctly concave faces and a curved stipe. Papillae are medium to large and distinctly rounded.

3.3. Identification of *Papaver Somniferum s.s.* (Opium Poppy, Papaveraceae)

Two seeds of *Papaver somniferum* ssp. *somniferum* were identified to species in sample 87C6S64b, and one in 94C6S9. One other seed in sample 87C6S1 had the characteristic reticulate testa pattern poorly preserved and consequently could only be identified as *Papaver* sp. It is likely to be *P. somniferum s.l.* by size and shape, however. It is notable that all four macro-fossils are from area C6. This may reflect differential usage of the various areas of the site, or could simply be a quirk of preservation.

The genus *Papaver* is easily recognisable from the hexagonal reticulum which protrudes from the testa surface. This overlies a smaller network, the possession of which prevents confusion with members of the Brassicaceae, should fossil remains only be fragmentary. *Papaver somniferum s.l.* can be separated from other members of the genus, including the closely similar sized *P. argemone*, by seed size (see diagram in Fredskild 1978). and the width of the generically characteristic testa reticulum elements. This last is larger and wider in *P. somniferum s.l.* than any of the other poppy species.

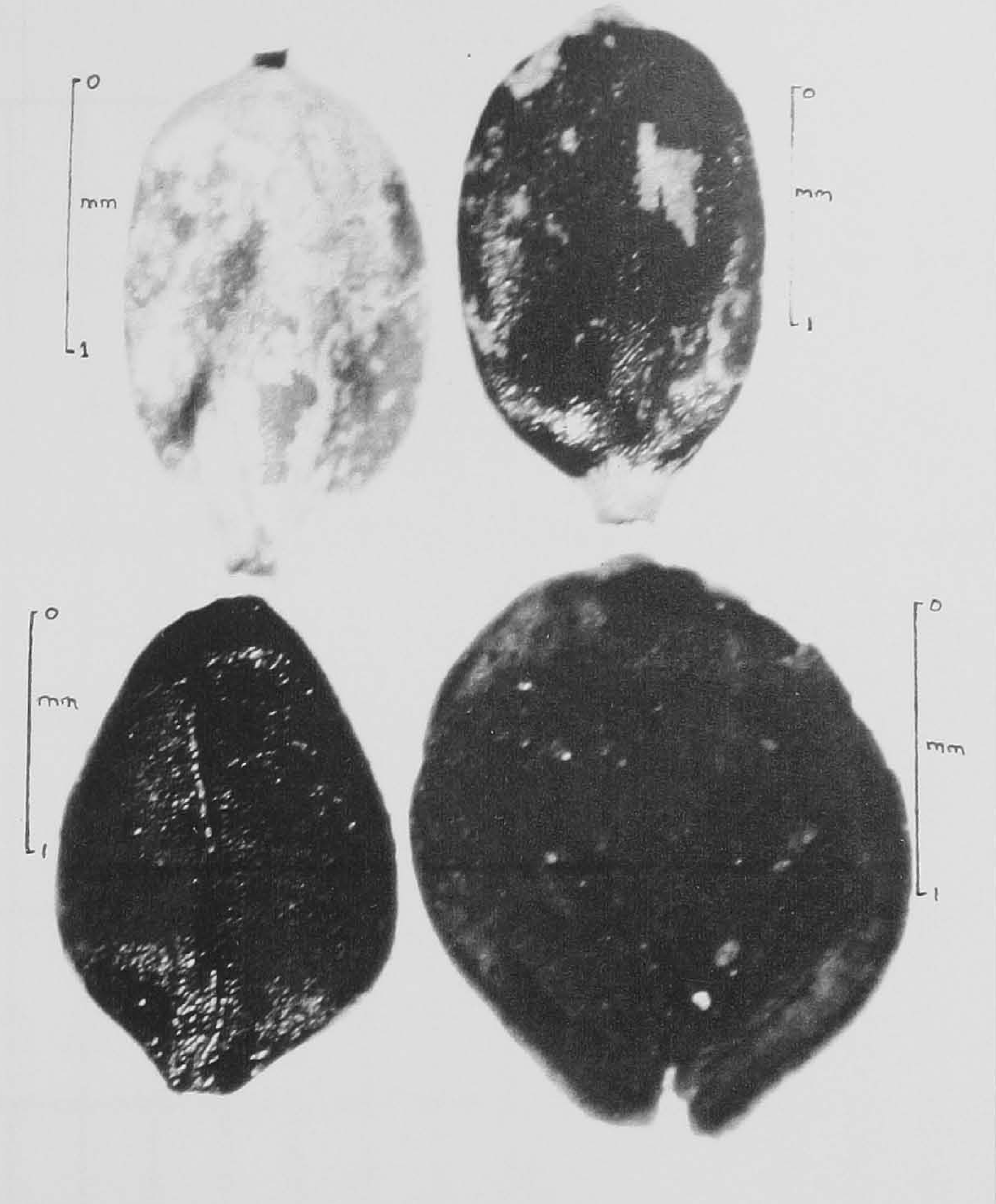


Figure 3.4. Biconvex Carex nutlets from Oakbank samples. (:top left *C. ovalis, C. disticha,* bottom left *C. echinata, C. nigra*)

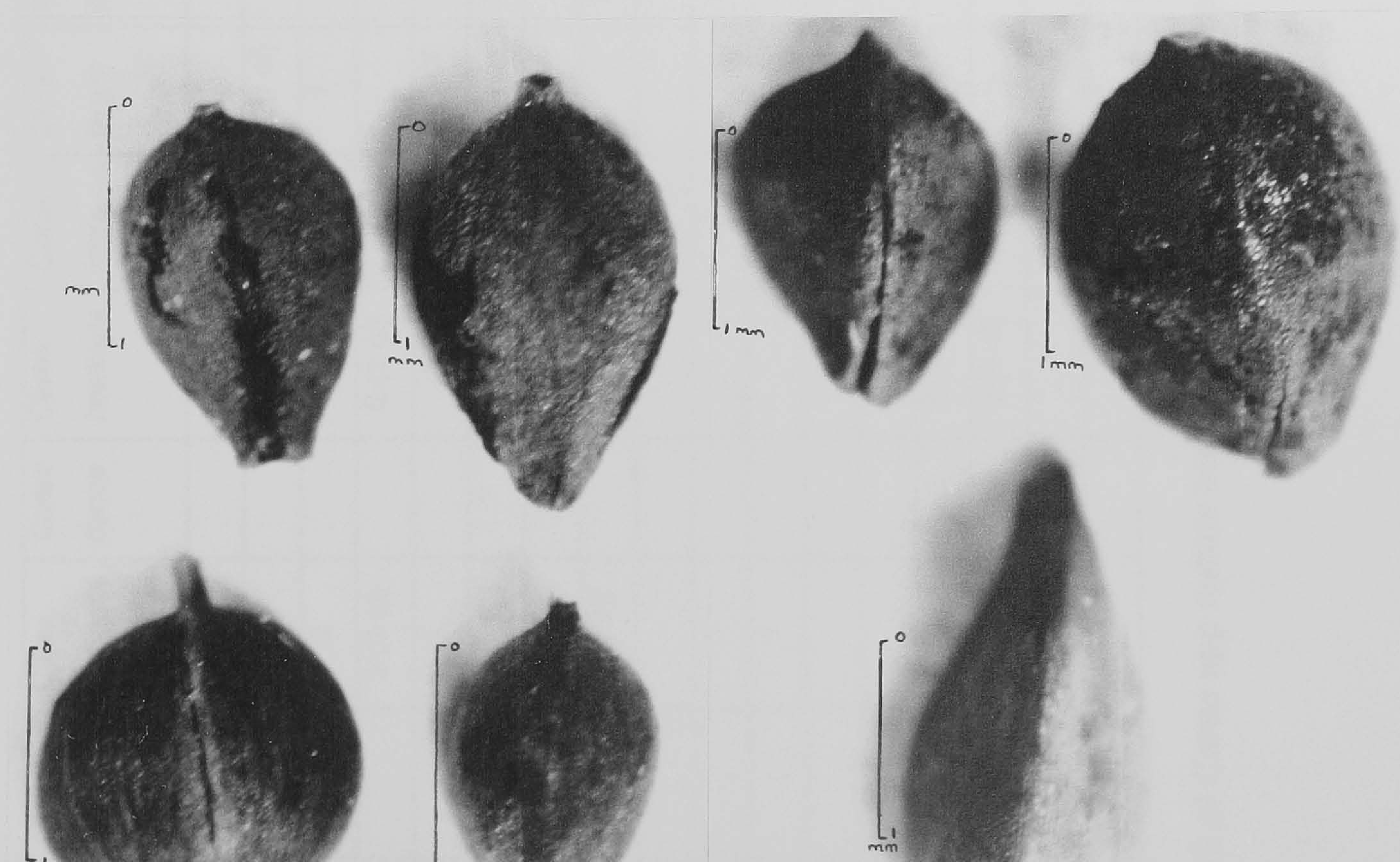


Figure 3.5. Trigonous nutlets from Oakbank samples. (top left *C. viridula s.l., C. hostiana, C. rostrata, C. panicea* bottom left *C. pilulifera, C. flacca, C. sylvatica*

Species/ Sample number	*Carex disticha*	*Carex disticha/ ovalis*	*Carex echinata*	*Carex flacca*	*Carex hostiana*	*Carex nigra*	*Carex ovalis*	*Carex panicea*	*Carex pilulifera*	*Carex rostrata*	*Carex sylvatica*	*Carex viridula*	*Carex viridula cf.* ssp *oedocarpa*	*Carex* indet.
81A3S4	1				2		1							1
87C6S1		1 (*cf*)			3 (1 *cf*)		22(I *cf*)	1			1		1	
87C6S5	1 (*cf*)		2		2		1							
87C6S6			3 (2 *cf*)		6 (1 *cf*)			2			1		13	
90A2S3	5 (1 *cf*)		1		5	1	3 (1 *cf*)				1		2	
90E2S5	2		2 (1 *cf*)	1	1	2							2	
91C1S8	2 (1 *cf*)													
91C1S5			5 (I *cf*)					2 (1 *cf*)					11	
91C1S6					1	1							2	1
91C2S7			1		1	2	1	4 (2 *cf*)	2 (*cf*)				5	3
94A2S5			1			2 (*cf*)	8 (1 *cf*)	1 (*cf*)	1	1			2	3
94C1S6						1								1
94C6S1	2									1	2			
94C6S2	4	1	2		3 (1 *cf*)	1				1 (*cf*)				1
94C6S4	12	13			6 (4 *cf*)	1		1 (*cf*)					4	2
94C6S9		8										9		
94D2S7	1	1 (*cf*)									1			

Table 3.1. Numbers of *Carex* spp nutlets from Oakbank crannog samples

P. somniferum ssp *setigerum* (DC.) Corb. used to be classed as a separate species, *P. setigerum*, until taxonomic revision of this rank placed it as the wild progenitor of *P. somniferum* ssp *somniferum* of the *Papaver somniferum* crop complex (Tutin *et al.* 1993, Zohary & Hopf 1993). This situation is now widely recognised in evolutionary terms.

The separation of seeds of the cultivated *P. somniferum s.s.* from the wild taxon *P. somniferum* ssp *setigerum* can only be satisfactorily achieved at the extremes of the size ranges, as although generally smaller, some wild forms bear fairly large seeds which overlap the size ranges of the cultivated types (Zohary & Hopf 1993). Renfrew (1973) cites references where ssp *setigerum* seeds are collectively sized at under 0.97mm, and photographs in Körber-Grohne *et al.* (1983) and reference material in this laboratory concur with this. However, reference material of *P. somniferum* ssp *setigerum* collected by Dr J.H. Dickson growing wild in Tenerife recently was smaller than this, in the region of 0.8mm. Although the plants were growing in association with *P. somniferum s.s*, the latter did not contain ripe seed.

Because of these differences in seed size and state of maturity it is suggested that the two lines were breeding true. Zohary & Hopf (1993) state that the diploid race of *P. somniferum* ssp *setigerum* is fully interfertile with *P. somniferum s.s* such that the small Tenerife reference ssp *setigerum* may be from the tetraploid race and not be part of the progenitor race that led to the cultivated ssp *somniferum* complex. However, the ssp *setigerum* material cited above by Renfrew and Körber-Grohne is still sufficiently smaller than these authors' descriptions of *P. somniferum s.s.* that the seeds can be satisfactorily separated apart from the smaller ones. Reference material at Glasgow University agrees with these findings. In particular, white seeds, which Renfrew (1973) calls var. *album* were large, to 1.4mm.

Number and size of the reticulum elements across the seed assists in confirmation of identification of seeds. The more rounded ssp *somniferum* seeds had a network with five, occasionally six elements across its width, each with a diameter of 0.2-0.3mm. Seeds of ssp *setigerum* were more elongate with smaller, more numerous reticulum elements across their girth (six, often seven). The diameter of these hexagons was 0.14-0.2mm.

The two seeds from sample 87C6S64b were 1.2 x 1.0mm and 1.3 x 1.0mm in size respectively. The first seed had five reticulum elements across its girth, of diameter 0.2mm, 0.22mm, 0.2mm, 0.24mm and 0.3mm (see figure 3.6.). The second seed had six reticulum elements but was more poorly preserved than the former and exact measurements were not possible. They were estimated as 0.25-0.3mm. On the basis of both size and number of reticulum elements, both seeds were confidently identified as *Papaver somniferum* ssp. *somniferum*, the cultivated opium poppy.

One seed from context 94C6S9 yielded a seed which had the characteristic *Papaver* reticulum, with five elements across its width. These had an approximate diameter of 0.25-0.3mm, although measurements were not able to be accurately taken. The seed was 1.3mm x 1.0mm and was identified as *Papaver somniferum* ssp. *somniferum*.

3.4. Identification of Waterlogged Cereals (Poaceae) at Oakbank

Entire and fragmentary waterlogged caryopses of cereals have been identified on several occasions in the recent past, in pits, wells and midden deposits. (e.g. Körber-Grohne, 1967, Körber-Grohne *et al* 1983, Robinson 1987). Similarly cess deposits have yielded bran fragments, such as the Roman ditch fills at Bearsden, (Dickson 1989) and Paisley Abbey drain system (Dickson 1996). On rare occasions, the discovery of coprolites (Knights *et al.* 1983, Bell & Dickson 1989) and bog bodies with *in situ* alimentary systems (Helbaek 1950, 1958, and Holden 1995) have given insurmountable proof of the use of the original grain. In general, however, the intended or actual use of waterlogged fossil seeds of any description must be a matter for conjecture. Nevertheless, a cereal (or incidentally a pulse) crop is something which must be sown, tended, possibly weeded, and cultivated, with the result that the end product is a valuable commodity, especially in a small agricultural community. The storage and uses of the grain are likely to have been the most efficient available.

With these parameters in mind it is often possible to work out the likely uses for grain assemblages found in wet deposits, especially when they are considered together with their contemporary weed assemblages. This is discussed in detail in the section on crop processing. The processing stage at which the cereal caryopses became incorporated into fossil assemblages can also be ascertained (Hillman 1981) and can determine whether the processing was on site, or elsewhere. Körber-Grohne *et al.* (1983) suggested that large amounts of spelt in a well at Welzheim found as intact spikelets implied the dumping of spoiled grain from the castle nearby where they were most likely being processed.

The bran coats of cereal grains are composed of various cell layers, as illustrated in Winton (1916) and Winton & Winton (1945). Photographs and useful descriptions are given by Körber-Grohne (1964 &1991), and Dickson (1987 & 1989). Table 3.2. shows the number of large Poaceae caryopses identified from Oakbank crannog. The criteria employed in their identification are described below.

3.4.1. *Triticum and Secale* Identification

Bran fragments of *Triticum* are not readily distinguishable from *Secale* unless the transverse cells of the pericarp are well preserved. *Secale* transverse cells are (70-100(125)µm x (15)18-45µm). *Triticum* cells by comparison are (70-280µm x (10)12-18µm) (Dickson 1987). *Secale* transverse cells are usually shorter and deeper than those of *Triticum*, and have more frequent cells half-size or less. *Triticum* only has this feature in small groups on the dorsal surface (Dickson 1987). However, the diagnostic transverse cells are not commonly preserved unless there has been fungal contamination to such a degree that the cell walls are largely replaced by invading hyphae. In these instances the side and end walls of *Triticum* transverse cells are distinctly pitted and the end walls are thin. This contrasts with *Secale*, which has no pits but distinctly thickened end walls (Winton 1916, Winton & Winton 1945, Körber-Grohne 1991, Dickson 1987) Care must be taken when only a few transverse cells remain, however, as the length and breadth of these varies somewhat depending on their position on the grain, and between species too to some extent (Holden 1986). In these instances it is doubtful whether generic identification is possible. The Oakbank cereal remains have only yielded a very few examples where this was achievable.

Tube cells may be present in the endocarp between the transverse and spermoderm cells, as an interrupted layer of detached vermiform individuals. (Winton 1916) They are most commonly found at the dorsal side and ends of the grain (Dickson 1987) and may help in identification if prolific. Many, narrow tube cells are characteristic of *Triticum monococcum* (einkorn) (Dickson 1987). This species was unlikely to be found at Oakbank as it is most frequently discovered in Neolithic deposits in the British Isles, apart from one Roman occurrence thought to be due to importation (Straker 1984)

Although the separation of wheat from rye on the basis of waterlogged pericarp fragments is problematic, identification to the level of *Triticum/Secale* is readily possible, even in poorly preserved material. This is due to the outer and inner layers of the spermoderm cells underlying the upper testa which both cereal types have. These cells lie at right angles to each other, imparting a characteristic "cross-hatched" appearance to the testa which is also a characteristic light brown, and with little or no pigment accumulation within the cells. The great majority of *Triticum/Secale* found at Oakbank was in this condition. Any identifiable *Secale* found at this age of site is likely to have been a weed, however, and not part of a main crop (Greig 1991).

The occasional *Triticum* testa fragment or individual that was identifiable to species from Oakbank crannog samples (see figure 3.7.) can be presumed to be either *T. dicoccum* (emmer) or *T. spelta* (spelt) (Greig 1991). *T. dicoccum* became popular in the Neolithic, gradually overtaking *T. monococcum*, which gives a poorer yield.

By the end of the Bronze age, when Oakbank was thought to be first inhabited, *T. spelta* was also known in England, although its' discovery at Oakbank by Clapham and Scaife (1988) and this author are the earliest such finds for Scotland.

3.4.2. *Hordeum vulgare* Identification

Entire caryopses of waterlogged *Hordeum vulgare s.l.* (6-row barley) are readily recognisable and can be initially sorted by low power microscopy. They have a darker testa than that of *Triticum* or *Secale*, and a characteristic flattened top which has a prominent central tip. Fragments of testa are recognised by their diagnostic double cell layer, comprising the testa and nucellar epidermis (Winton 1916). These cells are sub-rectangular to oblong, varying in shape and orientation with their position on the grain. Diagrams of this arrangement are given by Körber-Grohne (1964 &1991). *Hordeum vulgare s.l.* has a thick central hilum running the full length of the grain which is a characteristic feature. Two fine lines of dark pigment running parallel and adjacent to the hilum are seen on hulled types *Hordeum vulgare* ssp *vulgare,* as the result of contact with the adjoining glumes (see figures 3.8. and 3.9.). Similar lines are evident on the dorsal side for the same reason. This is not seen on naked barley (*H. vulgare* ssp *nudum*) caryopses.

In the Neolithic era barley was the primary crop grown in Scotland (Boyd 1988, Greig 1991). This was the case in most of the country, and is paralleled by the Netherlands and northern Germany. (Körber-Grohne 1981) In the Bronze age *Hordeum vulgare s.l.* was still of the utmost importance, but with small amounts of other cereals coming to the fore, depending on the area. Both hulled and naked forms were found to have been growing concurrently in the Bronze age, but gradually the hulled type became more popular (van der Veen 1992), except in remote areas such as Orkney (Dickson 1994). The preference for hulled barley may have been due to its better storage properties in the increasingly wetter climate of the Bronze and Iron Ages in Scotland. The naked type probably remained on a small scale due to familiarity, and as a relict in the more inaccessible areas.

3.4.3. *Avena* Identification

The cell layers of *Avena* species are transparent, with thin-walled oblong testa cells arranged in groups in a characteristic “herring-bone” pattern. The absence of any pigment in these means they can be easily recognised under high power. Fragments retaining the thin hilum are readily distinguishable (Dickson 1987). No such fragments were found at Oakbank. *Avena* sp fragments there were few and lacked the characteristic scar where the floret joins the rachis, such that specific identification was impossible.

3.4.4. *Bromus* Identification

Although not a crop in its own right, *Bromus* is a frequent weed of cereal crops (Greig 1991) and may have been encouraged, to boost the yield in times of need, or fed to animals in better years. This topic is discussed further in the chapter 7. Photographs of the various species of *Bromus* are shown by Körber-Grohne (1991). *Bromus* caryopses have a resilient testa and frequently preserve intact or as large fragments. The cells are arranged in groups and in *B. hordeaceus* and *B. secalinus* these are superficially like *Avena.* They are distinguished by the heavy pigment accumulation found inside cells of *Bromus,* which is a characteristic feature. All caryopses found at Oakbank were *B. hordeaceus/secalinus*, (see figure 3.9.), and are probably not *B. secalinus*, as this has a scattered southern English distribution (Perring & Walters 1976).

3.5. Identification of Glume and Spikelet Bases of Emmer and Spelt Wheat

Spikelet remains of the three glume wheats commonly found in the archaeological record, namely *Triticum monococcum* (einkorn), *T. dicoccum* (emmer) and *T. spelta* (spelt) are often more easily distinguishable than their respective caryopses, especially when these are waterlogged (van der Veen 1992). The identifying characteristics primarily include the distinctions between certain morphological criteria, and secondly the measurements across specific points (Jacomet 1987, Hillman unpublished teaching notes). The extensive literature deals mainly with carbonised material, however, as waterlogged chaff remains are more problematic to identify. Compaction and surface erosion mean that morphological characteristics can become so altered and confused that absolute identification is only feasible when preservation is good.

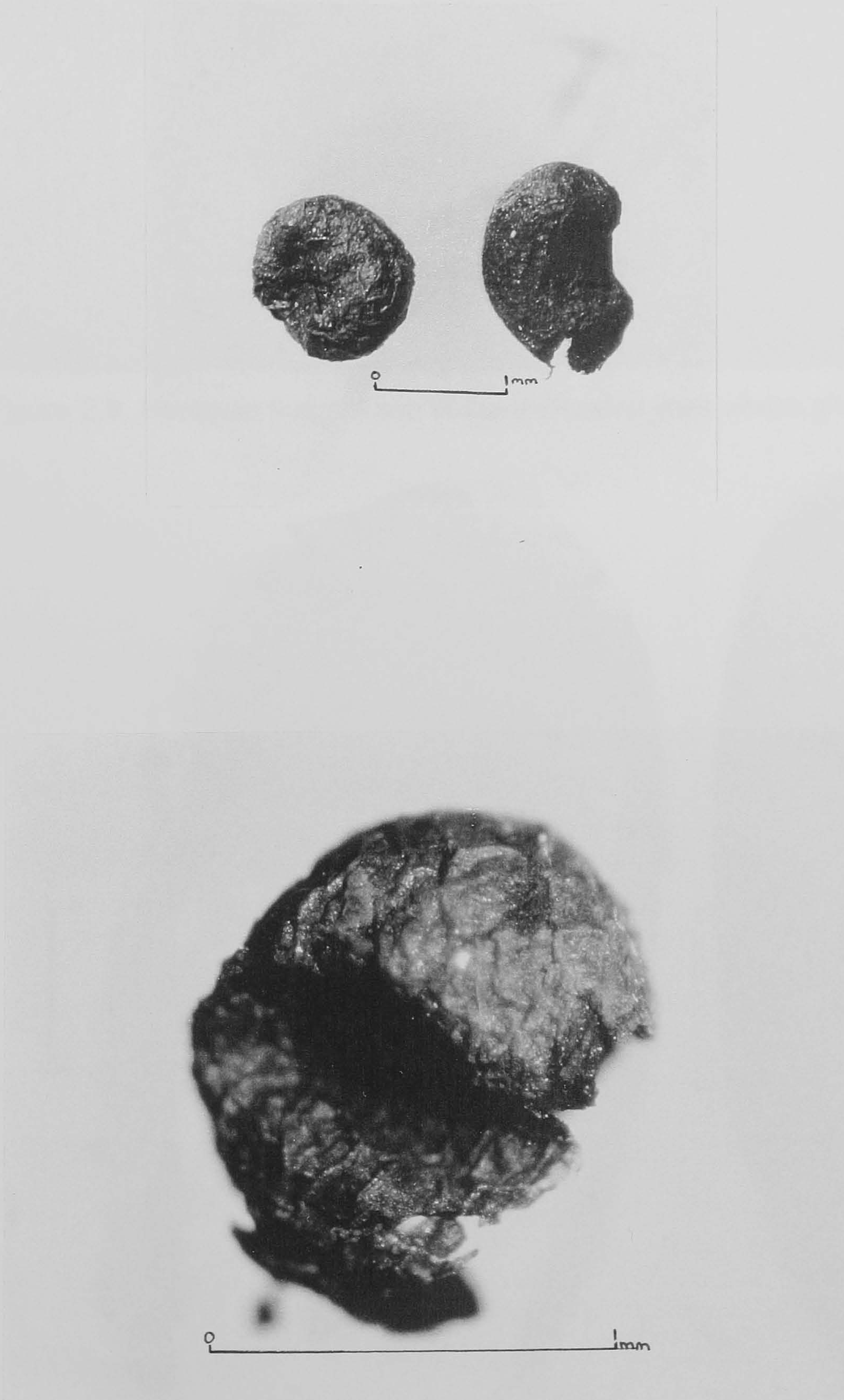


Figure 3.6. *Papaver somniferum s.s.* from 87C6S6 4b

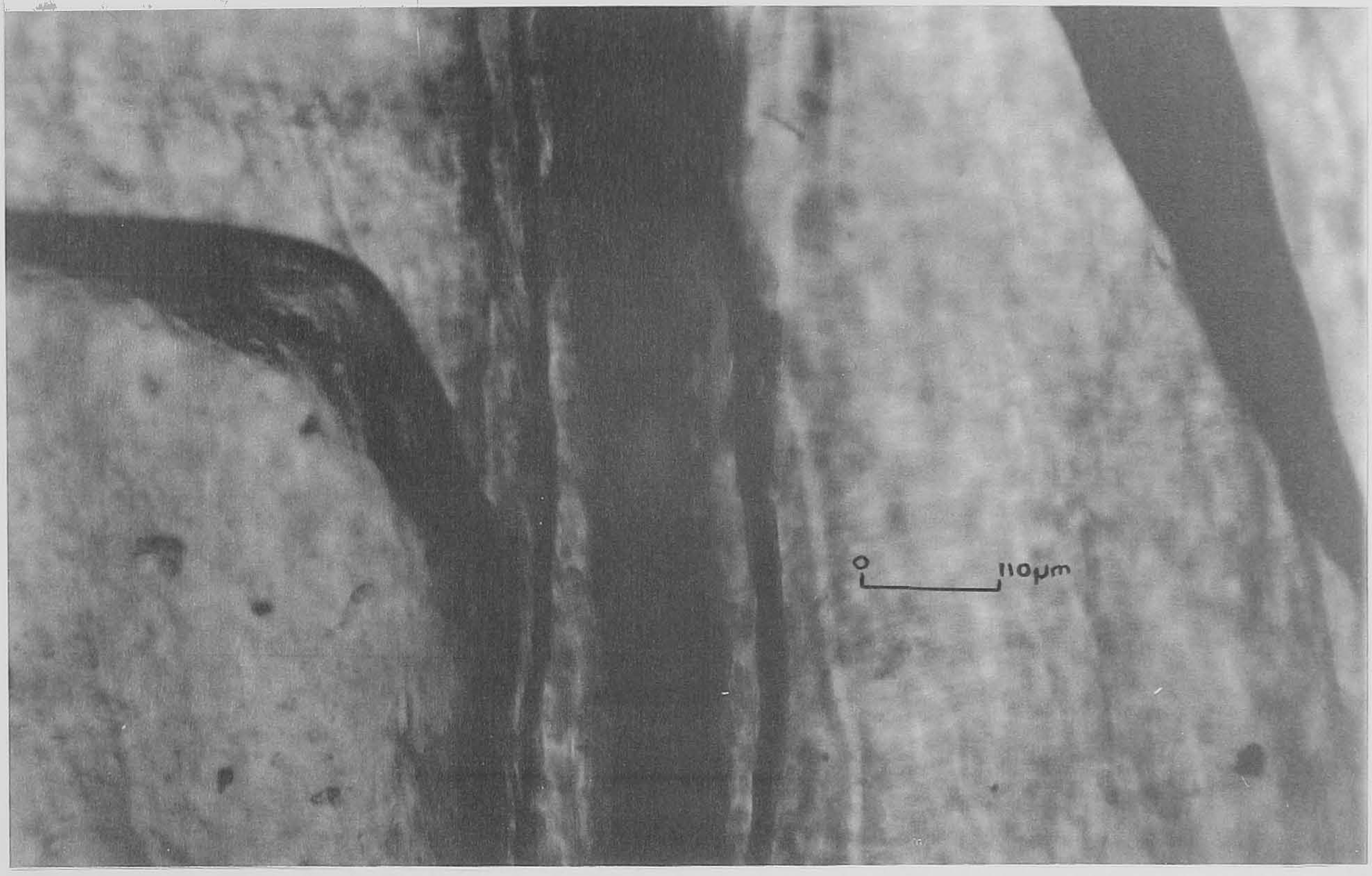
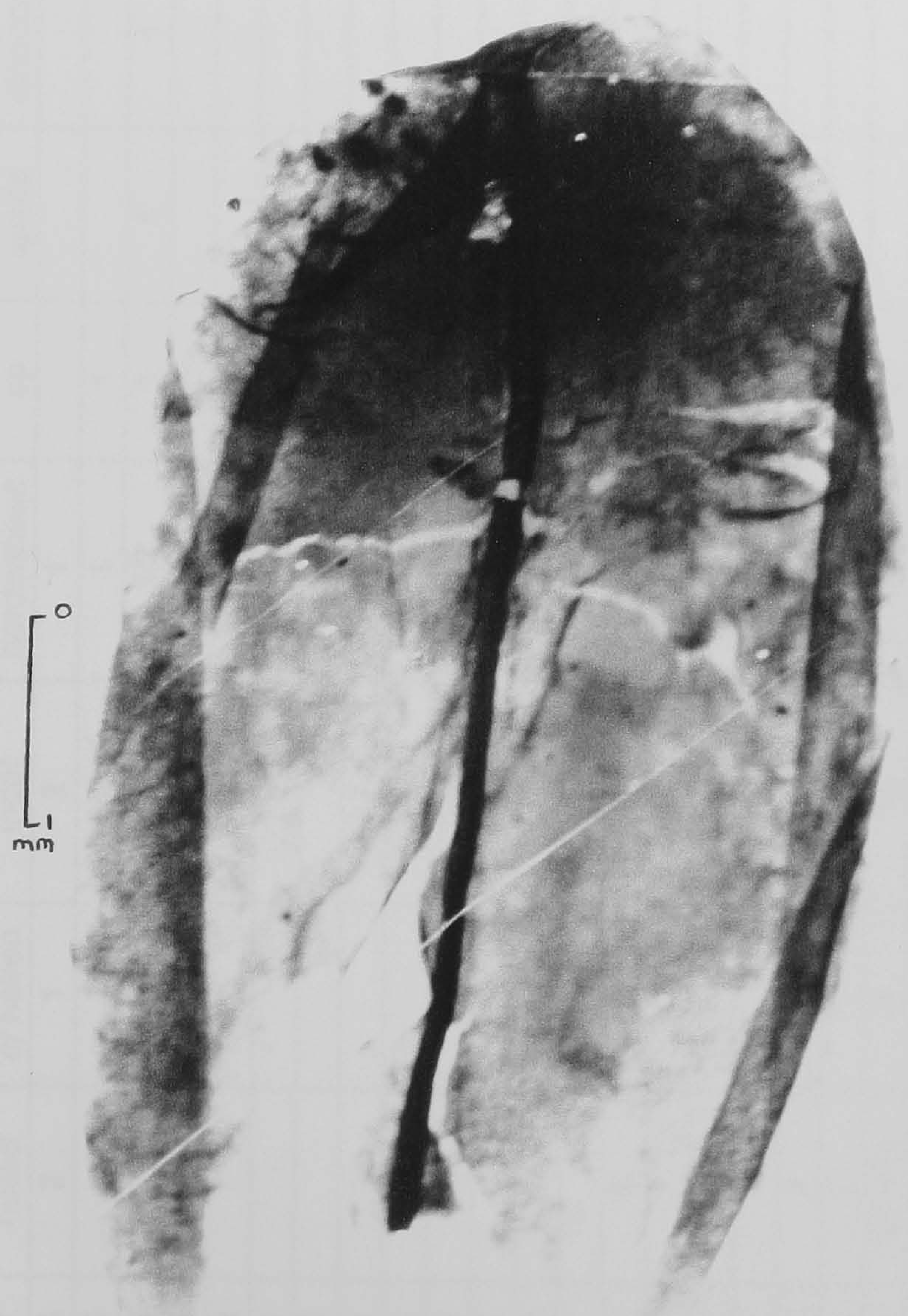


Figure 3.8. *Hordeum vulgare* ssp *vulgare* showing lines where glumes attached



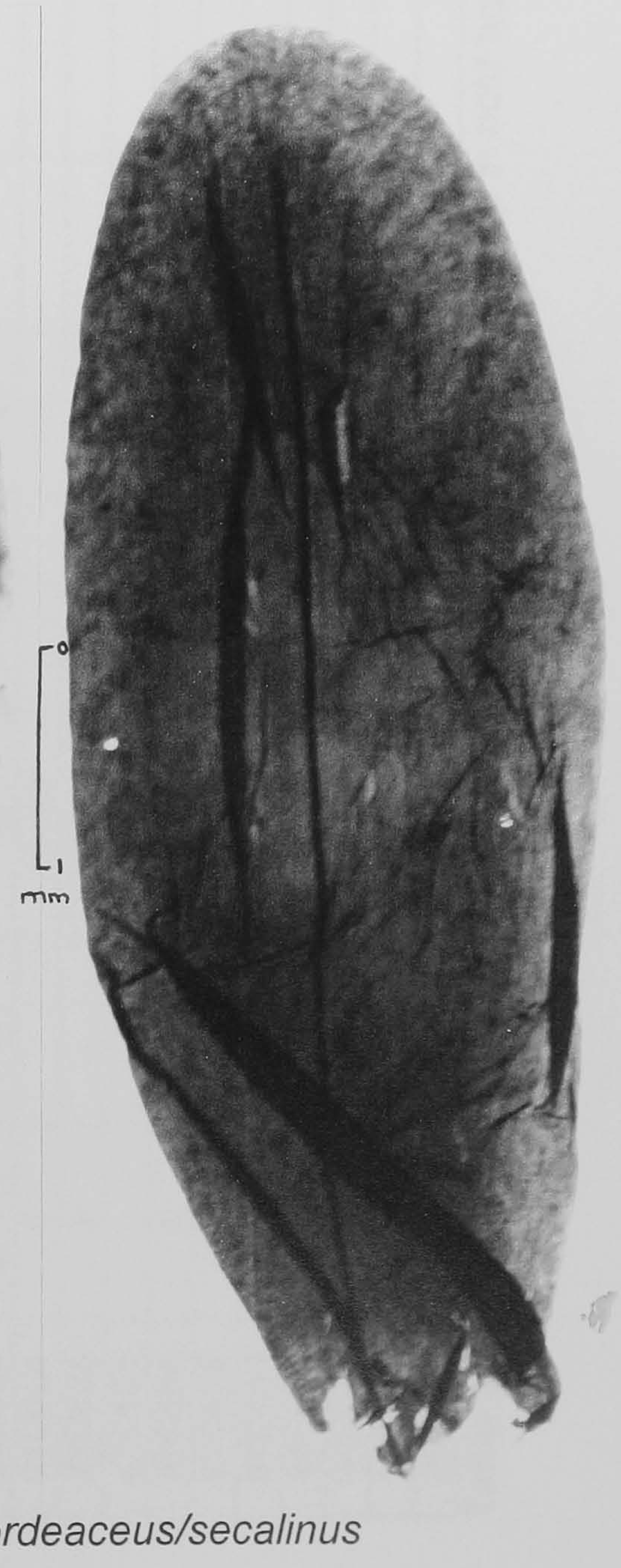


Figure 3.9. (left) *Hordeum vulgare* (right) *Bromus hordeaceus/secalinus*

Sample number	*Hordeum vulgare* hulled	*Hordeum vulgare* *cf* naked	*Hordeum vulgare* indet.	*Bromus hordeaceus*	*Bromus* sp	*Triticum spelta*	*T. spelta/ dicoccum*	*Triticum* sp	*Triticum/ Secale* sp	*Avena* sp	Poaceae sp
90A2S3	**2**	**1**	**2**	**1**							
90A2S3			31+1*cf*	1	1						1
94A2S5			**17**	**15**	**1**	**6**	**1**	**1**	**11**		**2**
94A2S5			105+1*cf*	4	23			12	25		11
81A3S4			**2**	**6**	**3**						
81A3S4			32+5*cf*		3			3	8	1	
94B4S8				**1**							
94B4S8			7	1				1	5		
91C1S6	**4**		**3**		**1**						
91C1S6	2		22+1*cf*		1			1	2		1
91C1S8			**2+1*cf***	**1**	**1**						
91C1S8	1		5+2*cf*						1		2
91C2S7			1	1	2				2		
87C6S1	**5**		**17+1*cf***	**24**	**3**			**1**	**1**		
87C6S1	1		27	6	2				6	6	9
94C6S1			**14+2*cf***								
94C6S1									1	1	
94C6S2	**3**		**30+1*cf*+1c**	**3**	**1**				**1**		**3**
94C6S2	2		11	1							
94C6S4	**20 +1c**	**3**	**18**	**50**	**4**			**2**	**5**		
94C6S4	3		13+1*cf*		11				7		10
87C6S5	**3**		**2**								
87C6S5			31+2*cf*	1	2						3
87C6S6	**5**	**3**	**10+1c+1*cf***	**2**							
87C6S6			47								
94C6S9	**2**		**16**	**12**	**2**				**1**		
94C6S9	5		90+1*cf*		11				7		10
94D2S7					1		1				
90E2S5			**1**								
90E2S5			1								

Table 3.2. Large Poaceae found in Oakbank samples. Intact caryopses in bold type. 'c' denotes carbonised

The identification criteria given in table 3.3. are those noted for emmer and spelt wheat from the Oakbank material, as shown in figure 3.10. They generally agree with those of previous studies, including Jacomet (1987), Körber-Grohne *et al.* (1983), Dickson (1989), and Hillman's unpublished but widely available teaching notes. Table 3.4. shows the number and types of cereal chaff remains of any kind from Oakbank.

Generally the venation in emmer glume bases is such that the primary and secondary keels are strongly developed, giving a 2-ridged shape to the glume in transverse section, with the tertiary veins in-between being relatively indistinct. Spelt, by comparison, has only the primary keel moderately well developed, with the secondary keel being indistinct from the tertiary veins. This causes the glume base to have only one visible angle in transverse section. Einkorn is almost absent in the archaeological record for the Bronze and Iron ages in Scotland, such that it was not surprising that there was no indication of the presence of einkorn in the Oakbank samples. Consequently it is excluded from further discussion.

Van der Veen (1992) describes the angle between the glume faces on either side of the primary veins as being characteristic in differentiating between emmer and spelt, with an angle of $\leq 90°$ in emmer, and of $>90°$ in spelt. This gives the spikelet bases their characteristic shape, as shown by Jacomet (1987 pages 53-4).

The width of the glume base in relationship to its length varies in a characteristic manner between emmer and spelt, which is only distinguishable in well preserved material. This ratio in emmer is approximately 1:1, whilst spelt, being longer and thinner, has a ratio of 1:2 or greater.

The breakage pattern of the rachis internodes also varies between emmer and spelt. Emmer normally breaks at the insertion point of the next highest rachis segment, such that fragments of the rachis are rarely seen (Jacomet 1987, Zohary & Hopf 1993). A torn edge to the scar implies domestic threshing (Hillman unpublished teaching notes) but in cases where the rachis segment remains, it is possible that the whole ear, or part of it, became incorporated into the matrix. Two spikelet forks of emmer from Oakbank samples showed this feature, suggesting that they were lost prior to close threshing, or were threshed when damp, and consequently tore.

Differences in the cell pattern of the long cells' sinuous walls in glume bases of emmer and spelt have been noticed by Körber-Grohne *et al.* (1983) and Dickson (1989). They reported that the sinuous walls had a zigzag pattern in spelt, whereas those of emmer were more rounded in general. This difference was not distinct enough in the Oakbank samples to merit classification status in the few examples sufficiently well preserved to be studied. Recent work involving infra-red analysis of Roman emmer and spelt has highlighted the discovery that the Romans may have brought their own 'Southern Spelt' with them (Frances McLaren pers. comm. to Camilla Dickson) and it may be that the cell pattern differences noticed by the two authors mentioned above are a peculiarity attributable only to Roman glume wheats at this time. McLaren is currently investigating the genetic and biochemical variations between emmer and spelt.

Minor differences noticed from the Oakbank samples may be characteristic to species, but verification of these would require further examination and study which is not relevant to this thesis. One such is the fact that in the Oakbank and Glasgow University reference emmer the tertiary veins on the glumes became indistinct towards the base such that a smooth outline is visible, whereas in spelt the nerves were clear right to the base. Also the Oakbank and reference emmer had an obvious narrow but relatively deep groove on the base of the glume if well preserved. This was parallel to the direction of breakage from the spikelet. Spelt also has a groove, but it is conspicuously shallower and more indistinct.

The recent discovery that southern spelt and emmer interbreed in Spain and have been grown together for many generations must be seriously considered. Francis McLaren has noticed (pers. comm. to C. Dickson) that the resultant hybrid looks like spelt, but still contains emmer characteristics, highlighting the issue of the purity of available reference material, and indeed of fossil remains. At this point in time, and without the benefit of a comprehensive comparative study of emmer and spelt, it is only possible to positively identify the best preserved waterlogged chaff remains of the two species. A large number consequently fit into the either/or category.

Criterion	Emmer	Spelt
angle and shape of lower part of the glume onto the spikelet	one glume has an upright, *c.* 90°angle, the other is obtuse	both glumes curve upwards evenly at about 90°
width of glume base	0.8mm-1.3mm	1.2mm-1.85mm
relationship of glume base width to depth (thickness)	approximately 1:1 ratio	approximately 2:1 ratio
shape of the lower part of the glume in transverse section	large, thick, square to slightly rectangular. Curves around the base	large, long and narrow. Shape obviously rectangular
breakage pattern of rachis internodes on the spikelet	mostly at insertion point of the internode above it, resulting in the internode persisting under the spikelet (may be eroded). Small scar at insertion point of next highest segment	commonly snaps at the top of the rachis internodes, so that spikelet finds still have remains of the rachis internode above it attached. If absent, a long scar is present
glume keels	main (1°) keel protruding. 2°keel (1st side nerve) clearly visible, giving glume base a smooth, rounded appearance. 3° veins indistinct in TS	1° (main) keel less distinct than emmer. 2° vein (1st side nerve) not distinct from 3°veins, which are obvious to base of glume in TS
groove on glume base	obvious groove on glume base if well preserved. Relatively deep	groove shallow and indistinct by comparison

Table 3.3. Criteria for differentiating between glume and spikelet bases of emmer and spelt wheat based on Oakbank crannog material

Figure 3.7. *Triticum* sp caryopses in the spikelet

Figure 3.10. Spikelet bases of (top) *Triticum spelta* and (bottom) *T. dicoccum*

Chaff type/ Sample number	Spikelet bases *Triticum spelta*	Spikelet bases *T. cf. spelta*	Spikelet bases *Triticum dicoccum*	Spikelet bases *T. cf dicoccum*	Glume bases *Triticum spelta*	Glume bases *T cf. spelta*	Glume bases *Triticum dicoccum*	Glume bases *T cf dicoccum*	Rachis *Hordeum* sp	Rachis indet.	*Triticum* sp spikelet/glumes *T. spelta/ dicoccum*	*Triticum* sp spikelet/glumes indet.	Poaceae culm nodes indet.
87C6S1			8	1	17		9		5		22	54	
87C6S5									5				
87C6S6			1	1	3		4	9		5			3
90A2S3				1									
90E2S5	1						1		1		2		
91C1S6	2								2				4
91C2S7	1	1	3	4	1	2	3	2			2		
94A2S5	11		7		33		23		8		9 spikelets	54 glumes	12
94B4S8	2					2						1	
94C6S1	2								2	1			4
94C6S2								1	1		3 glumes		
94C6S4	9		14		19		39		2	7	21 spikelets 62 glumes		6
94C6S9	1		1		2		7		16 +2*cf*	4	6 glumes		4
94D2S7						1							

Table 3.4. Number and types of cereal chaff found in Oakbank crannog samples.

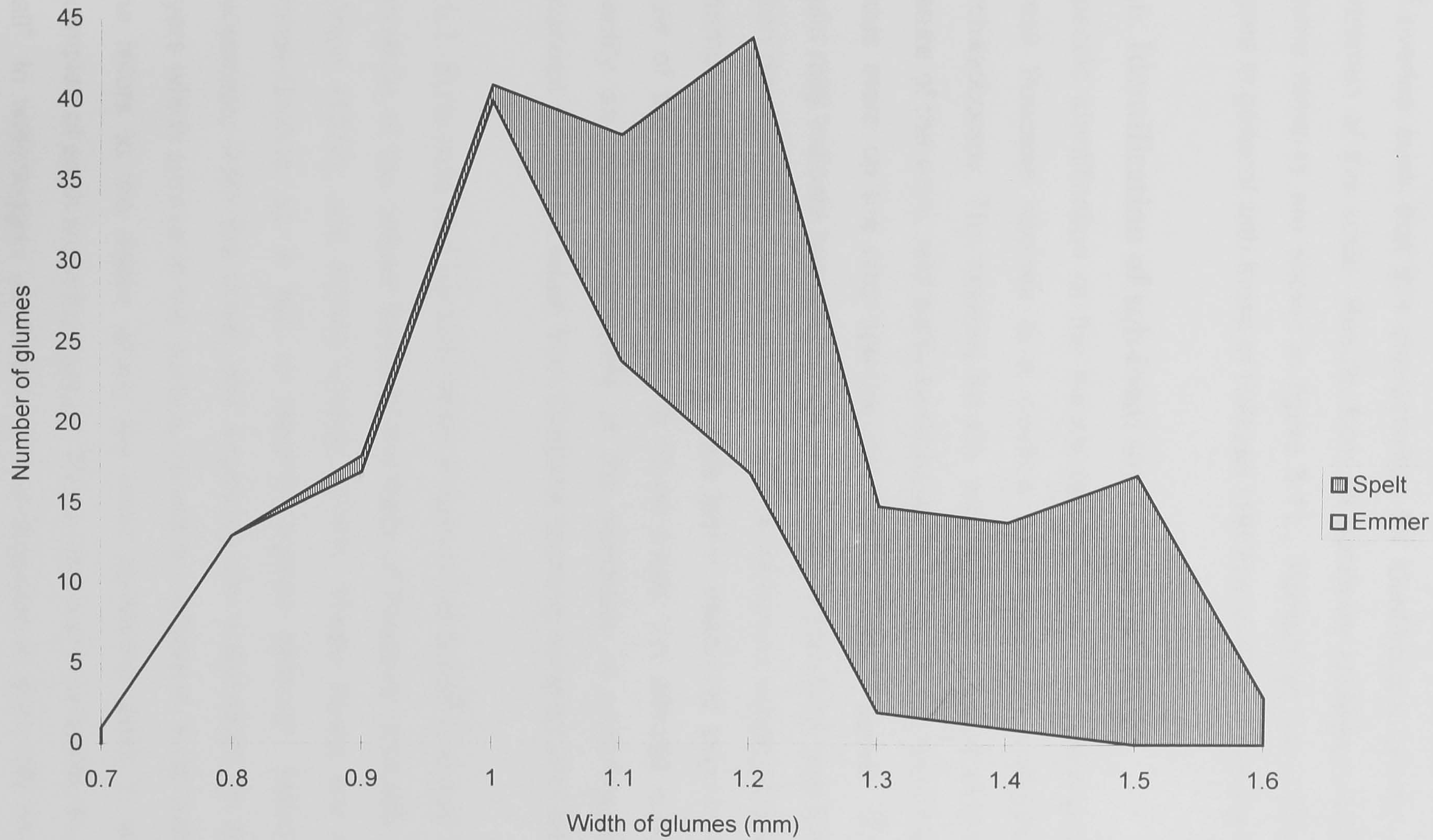


Figure 3.11. Width of emmer and spelt glumes from Oakbank crannog samples

The variation observed in the glume shapes and dimensions of emmer and spelt at Oakbank crannog was further compounded by variance in the width of the glume base of the two species. However there is a certain degree of overlap such that this characteristic for identification is only useful at the extremes of the scale. Results from all positively identified emmer and spelt glume remains are shown in figure 3.11., highlighting this point. The results agree in general with those of Helbaek (1952) and Körber-Grohne *et al.* (1983).

3.6. Identification of sub-fossil small Poaceae fruits.

Specific identification of the translucent caryopses of waterlogged sub-fossil small Poaceae species is a practice not frequently undertaken in British archaeobotany. The reasons for this are partly as a result of the problematic nature of the work, and partly because environmental analyses have tended to focus more on the crop species and their incidental weeds. Small Poaceae fruits may indicate land clearance for grazing, agriculture, and fodder, and are often discussed in these contexts in terms of human impact, but without much attempt at specific identification. This last is extremely important if a holistic view of the cultural landscape is to be made. An attempt is made here to identify as many as possible of the hundreds of waterlogged small wild Poaceae caryopses taken from Oakbank crannog samples (see table 3.5.).

3.6.1. Structure and Identification Pointers for Small Poaceae Fruits

Drawings of the cellular layers of the fruits of Poaceae generally are given by Winton (1916), and Körber-Grohne (1991). These layers are described by Körber-Grohne as a two to several layered pericarp, fused on to and inseparable from the testa, and enclosing the endosperm. In subfossils cell layers which survive in the various genera are different, so to avoid confusion, she refers to the layers which are most commonly seen in well-preserved examples of each individual genus. These layers are generally termed the "fruit wall". In waterlogged subfossils, the endosperm is generally lost and a flat, translucent envelope remains.

Species/ Sample	*Agrostis* sp	*Danthonia decumbens*	*Deschampsia caespitosa*	*Glyceria fluitans*	*Holcus lanatus*	*Holcus* sp	*Poa annua*	*Poa humilis*	*Poa pratensis*	*Poa trivialis*	*Poa* sp	Poaceae indet.
81A3S4	2		1	1					3			2
87C6S1	25	6			3		1	1 (*cf*)	17 + 3 *cf*	5	2	7
87C6S5	11	3	2					2	1	3	1	1
87C6S6	4	1	6 + 2 *cf*	1	7	2	4		2 + 2 *cf*	2 (*cf*)	1	8
90A2S3	10	2	1			1			2	1	1	1
90A2S7	2 (*cf*)										1 (*cf*)	
91C1S5	1								1 (*cf*)		3	1
91C1S6	3		1		3		1	2	1			2
91C2S7	4		1						5	1	1	1
91C1S8							2		1			
94C6S1			1					2		1		2
94C6S2	6		2		3	1			3	4 + 1 *cf*	3	5
94C6S4	19	5	2 + 1 *cf*		4	1	1	1	23 + 3 *cf*	13 + 5 *cf*	5	8
94A2S5	1		1	1				1	2	2	1 (*cf*)	2
94D2S7			1 (*cf*)								1 (*cf*)	
94B4S8	5	2	2	2 + 1 *cf*	2		8		3		2	2
94C6S9	50 + 3 *cf*	1	4 + 3 *cf*	1	20	5	1		14 + 2 *cf*	5	4	13
TOTAL	142 +5 *cf*	20	25 + 7 *cf*	6 + 1 *cf*	42	10	18	8 + 1 *cf*	77 + 11 *cf*	32 + 8 *cf*	23 + 3 *cf*	55

Table 3.5. Number of each species of small Poaceae found in Oakbank samples

Initial observations on the shape and size of the fruit and its hilum characteristics allow classification to generic level. The length of the fruit, shape of the apex, length to breadth ratio, and plane of flattening are all useful identification pointers. The position of the hilum on the empty caryopsis will designate the original shape of the fruit. If the hilum has a position to one side, then the fruit was initially rounded, (e.g. *Poa* spp), whereas a median position denotes a dorsally/ventrally flattened grain (e.g. *Bromus* spp) (Körber-Grohne 1991). The colour, shape, length to breadth ratio and position with respect to the fruit base of the hilum is similarly useful.

Following this, a study of the fruit wall cells will allow identification to species in many cases. The shape, size, and degree of pigmentation of the cells is important for this specific diagnosis.

In some genera, however, the variation within species is such that absolute classification is not feasible. This is true of the 3 *Agrostis* species described by Körber-Grohne (1991) which can be separated only infrequently and on the basis of the shape and colouration of the hilum. The exception is *A. gigantia*, a species not in this key, which is entirely different. In the absence of an extensive reference collection, The author has designated the Oakbank crannog Agrostis as *Agrostis* sp, but has noted that the range was such that both the dark, plump hilum type of *A. capillaris* and the pale, almost invisible hilum type of *A. canina* were present.

3.6.2. Identification Features of Species of Small Poaceae Found at Oakbank Crannog

Special reference was made in all cases to Körber-Grohne's (1964 & 1991) identification keys and photographs taken from a combination of artificially fossilised modern grains and sub-fossil material, although these keys do not include all the British native species. Consequently, reference was made to artificially fossilised material in the laboratory to ensure absolute identification.

The species identified from Oakbank crannog (OB) were as follows:

Agrostis spp (bents)

Danthonia decumbens (heath-grass)

Deschampsia cespitosa (tufted hair-grass)

Festuca cf rubra/ovina (red/sheep's fescue)

Glyceria fluitans (floating sweet-grass)

Holcus lanatus (Yorkshire fog)

Poa annua (annual meadow-grass)

P. humilis (spreading meadow-grass)

P. pratensis (smooth meadow-grass)

P. trivialis (rough meadow-grass)

Representative subfossils are photographed in figures 3.12. and 3.13.

3.6.2.a.Separation of small Poaceae other than *Poa* spp

(see figure 3.12)

Agrostis spp. Bents. Fruits are small, narrowly to relatively widely oval, with a bluntly pointed apex and a triangular to linear hilum near the base.

(OB) 0.9-1.3mm x 0.4-0.6mm, hilum 97-162µm x 56-81µm.

Fine pigment lines radiate from the hilum towards the apex of the fruit, for approximately $^{1}/_{3}$ of its length. Fruit wall cells have a distinctive central panel of longitudinally elongate cells with slanted cross walls, (OB 51-82µm x 10-18µm). Cells to either side of this are irregularly arranged and obscure, but still retain sloping cross walls where visible. The hilum is frequently less than the 2:1 length to breadth ratio suggested by Körber-Grohne's (1991) key, with a range from 1:1.3 to 1:2 being most common in subfossils examined. This puts them within the *A. capillaris/canina* range. Few fruits were above this ratio, although several had a longer, narrow hilum and were possibly of the *A. stolonifera* type. A few were much larger, and in these cases *A. gigantia* is suggested.

The hilum in *Agrostis* is not a uniform dark colour like many *Poa* species, and can range from mid-brown with a darker outline to very pale and indistinct. The hilum range in Oakbank fruits was 97-162µm x 56-81µm. This is smaller than the hilum seen in the majority of P*oa* fruits examined too, and is another useful factor to distinguish between *Agrostis* and *Poa* species.

Körber-Grohne (1991) suggests that the shape and colour of the hilum may also be useful in the separation of *A. stolonifera, A. capillaris,* and *A. canina*, but the variability in the Oakbank fruits is such that such a separation could only be tentative, and in the most extreme cases. Nevertheless, it is thought that all three were represented.

Danthonia decumbens. Heath-grass. Broadly elliptic with a rounded apex.
(OB)1.7-2.4mm x 0.9-1.4mm, hilum 650-810µm x 97-129µm.
With its dark pigmentation and long, pale hilum, this species is one of the most distinctive of all the small Poaceae. All cells have a deep brown pigmentation, and are longitudinally elongate with distinctly sinuous margins. (OB 41-62µm x 20-33µm). The hilum is a very pale brown with fine lines radiating out from it. Körber-Grohne (1991) observed that subfossils from Welzheim and Freiburg showed a dark hilum, but this was not the case at Oakbank (see figure 3.12.).

Deschampsia cespitosa. Tufted hair-grass. This species shows the same considerable dark brown pigment deposits as *Danthonia decumbens.* Körber-Grohne (1991) describes this appearance as a "metallic shining red-brown". Pigment can be located evenly or in a mottled reticulate manner. The outline of the fruit is somewhat reminiscent of *Poa* species, being somewhat pointed at both ends, or with a rounder apex. but the pigmentation is far more pronounced than in that genus (see figure 3.12.).
(OB) 1.7-1.95mm x 0.7-0.8mm, hilum 202-243µm x 120-150µm.
The fruit wall cells of *Deschampsia cespitosa* are elongate with slanting cross walls in the same manner as *Agrostis*, but these are throughout the whole face in this species. Cell sizes of subfossils were (OB) 180-202µm x 28-32µm. The hilum was typically a mottled brown colour in subfossils. *D. cespitosa* can be separated reliably from the other common native British species, *D. flexuosa*, by the larger size of fruit in the latter, and the shape of its cell walls (Körber-Grohne 1991), which are small and 4-6 sided.

Festuca *cf rubra/ovina*. Red/sheep's fescue. One sub-fossil from sample 94C6S4 was identified as *Festuca* sp. The fruit was an even brown colour, bluntly pointed at the apex, and with a slender outline.

(OB) 2.05mm x 0.8mm, hilum 1290μm x 48.6μm

The long, pale, narrow hilum was slightly to the left side and had faint lines radiating from the top. It stopped 0.4mm from the apex. The fruit wall cells were elongate and diagonally arranged with respect to the hilum. These characters agree with Körber-Grohne's (1991) descriptions, although the fruit is smaller than her types. She notes considerable variations between subspecies and locations, however, and some of our reference material is under 2mm. Körber-Grohne also notes that distinguishing between *F. ovina* and *F. rubra*, is uncertain, with the difference being due to the shape of the apex, and the size and clarity of the diagonal fruit wall cells. It was thought that this could not be ascertained for this sub-fossil. It is put as *Festuca cf rubra/ovina.*

Glyceria fluitans. Floating sweet-grass. Fruits were uncommon but generally well preserved enough to allow specific identification. The different species are separated from each other by a combination of size, width of hilum, and size and numbers of cells in each half of the fruit. (Körber-Grohne, 1964, 1991)

(OB) 2.2-2.35mm x 0.9-1.0mm.

The rounded caryopses examined had a long, narrow hilum, almost the length of the fruit. Several were torn down the length of the hilum, preventing any accurate measurement, but one was accurately measured as 40.5μm wide x 2.0mm long.

The caryopses also had a distinctive two layered fruit wall, the outer layer of which consisted of small polyhedral cells, generally 23-27 in number per half caryopsis, degraded in parts, and exhibiting extensive pigmentation. Both the cell counts and hilum length agree with the descriptions given by Körber-Grohne (1991). The inner cell layer was composed of large paler coloured, rectangular cells with undulating margins, (Körber-Grohne 1991, p219). These cells were 41-94μm x 20-25μm at Oakbank. *G. maxima* can be discounted using these criteria, as it has fewer, larger cells and a broader hilum than this.

G. fluitans is ultimately distinguished from *G. notata* and *G. declinata* by size, being a larger fruit. *Glyceria* are separated from *Molinia* species by the broader hilum of the latter genus. The combination of characteristics shown by Oakbank subfossils was such that the majority could be identified as *Glyceria fluitans.*

Holcus lanatus. Yorkshire fog. The slender caryopses of *Holcus* sp have a bluntly rounded apex and a pale colouration interspersed with transverse flecks of darker pigmentation.

(OB) 1.5-1.94mm x 0.55-0.7mm, hilum 202-283µm x 56-81µm.

Fruit wall cells are indistinct, but both *H. lanatus* and the other native *H. mollis* (creeping soft-grass) have frequent small transverse folds on the fruit wall, which look like short, parallel lines under x40 magnification. The hilum is dark, linear and fairly long, with a somewhat lateral position. This is enclosed within a broad, longitudinal fold in *H. lanatus* (Körber-Grohne 1991). The separation of *H. lanatus* and *H. mollis* is achieved by the length of the hilum, which is distinctly shorter in *H. mollis*, which also lacks the longitudinal fold (Körber-Grohne 1991). Most entire caryopses were distinguishable as *H. lanatus* (see figure 3.12.). however, some identifications were tentative due to degradation. Fragments and one immature fruit were only classifiable as *Holcus* sp.

3.6.2.b. *Poa* spp separation and identification

4 species of *Poa* were reliably identified at Oakbank (see figure 3.13.). Many subfossils were either too degraded, obscured, or variable to be entirely certain, and in many cases only '*cf*' was possible. Even poorer examples were classified *Poa* sp.

Identification to the genus *Poa* relies on several collective features, based on the general shape, hilum, and fruit wall characteristics, as before. *Poa* species are generally between 1-2.1mm long (Körber-Grohne 1991), with a small hilum which is most frequently a uniform dark brown, situated near the base, somewhat to one side. The hilum is round, oval, or triangular, and this feature aids specific identification. In the fruits examined it was noted that the hilum of many *Poa* species is generally bigger than that of *Agrostis* species, which may be a general feature, and could aid separation of *P. trivialis* (which has a triangular hilum) from the *Agrostis* group.

All species except *P. annua* have an indistinct 2 layered effect on the fruit wall, with blunt ended longitudinally elongate cells. The dimensions of these cells varies with position, with those at Oakbank being longest in the centre of the fruit, (OB 81µm x 24µm long average) and more irregular and distorted at the apex (OB 40µm-65µm long). Towards the hilum the cells have more slanting cross walls. However, this may be an effect of distortion caused by the hilum, which frequently has lines radiating from it. All cells have brown pigmentation, but the deposition of this varies and aids specific identification (Körber-Grohne 1964, 1991).

Poa annua. Annual meadow-grass. The outline of these caryopses was broad and rounded, mostly with a blunt apex.

(OB) 1.1-1.5mm x 0.7-0.8mm, hilum 97-162µm x 97-170µm

This species is distinct from other *Poa* types in having a layer of hexagonal cells with grossly wavy margins (OB 41-66µm x 31-48µm long) as the most clearly preserved layer. Oakbank subfossils occasionally had remnants of a layer of long cells extant, but this was indistinct. The large dark hilum is distinct and rounded, to the side of the fruit. The separation of *P. annua* from *Phleum pratense* is achieved by the observation of the hexagonal cell layer. *P. pratense* has intermediate cell walls, giving the appearance of small cells in between the larger ones (Körber-Grohne 1964, 1991).

Poa humilis spreading meadow-grass, & *P. pratensis* smooth meadow-grass.

The specific identification of species of *Poa* other than *P. annua* initially involves observations on the shape of the hilum, which is round or oval in all except *P. trivialis.* Separation of *P. humilis* and *P. pratensis* from the rest of the genus is only feasible when the apex of the caryopsis is intact, and the pigmentation not degraded. Shape of the outline of *P. humilis* and *P. pratensis* is oval to broadly oval, with a bluntly rounded apex, although photographs of *P. pratensis* in Körber-Grohne (1964) were bluntly pointed. Neither this nor the 1991 key mentions *P. humilis.* Subfossils from Oakbank were not so distinctly pointed, which may be a community characteristic for this site. The separation of *P. humilis* and *P. pratensis* is achieved in well preserved examples by the pattern of pigment deposits in the fruit wall cells. *P. humilis* has a series of longitudinal striations which are distinct. Comparatively, *P. pratensis* has a mottled network, which can be faint or well defined. The combination of shape, size and pigmentation assists identification. Dickson (forthcoming) identified this species from Neolithic Skara Brae.

P. humilis fruits from Oakbank were:

(OB) 1.2-2.0mm x 0.5-1.0mm, with a hilum of 243-283µm x 210-283µm.

P. pratensis fruits from Oakbank were:

(OB) 1.05-2.0mm x 0.45-1.05mm, hilum 162-324µm x 162-283µm, although many were towards the lower extent of the range. The various pigmentation patterns size ranges and general outline of several other *Poa* species is detailed in Körber-Grohne (1991).

Poa trivialis. Rough meadow-grass. This species is distinguished from others in the genus by its triangular hilum, bluntly pointed apex and longitudinal pigment striations.

(OB) 1.3-1.9mm x 0.5-1.0mm, hilum 218-284µ x 137-162µm.

Other species which usually show a rounded hilum may appear oval, but this is still discernible in many cases from that of *P. trivialis.* Cases where fruits show an elongate oval hilum, bluntly pointed apex, and longitudinal pigment striations can only be tentatively identified, and these fruits have been designated *P. cf. trivialis.*

3.7.Identification of Problematic and Rare Rosaceae Family Remains.

3.7.1. *Rubus chamaemorus* (cloudberry)

Five fruit-stones (seeds) of Rubus chamaemorus were found in samples 94A2S5 and 87C6S1. Area A2 is near the walkway where there would have been household dumping. Area C6 is from a context within the extension.

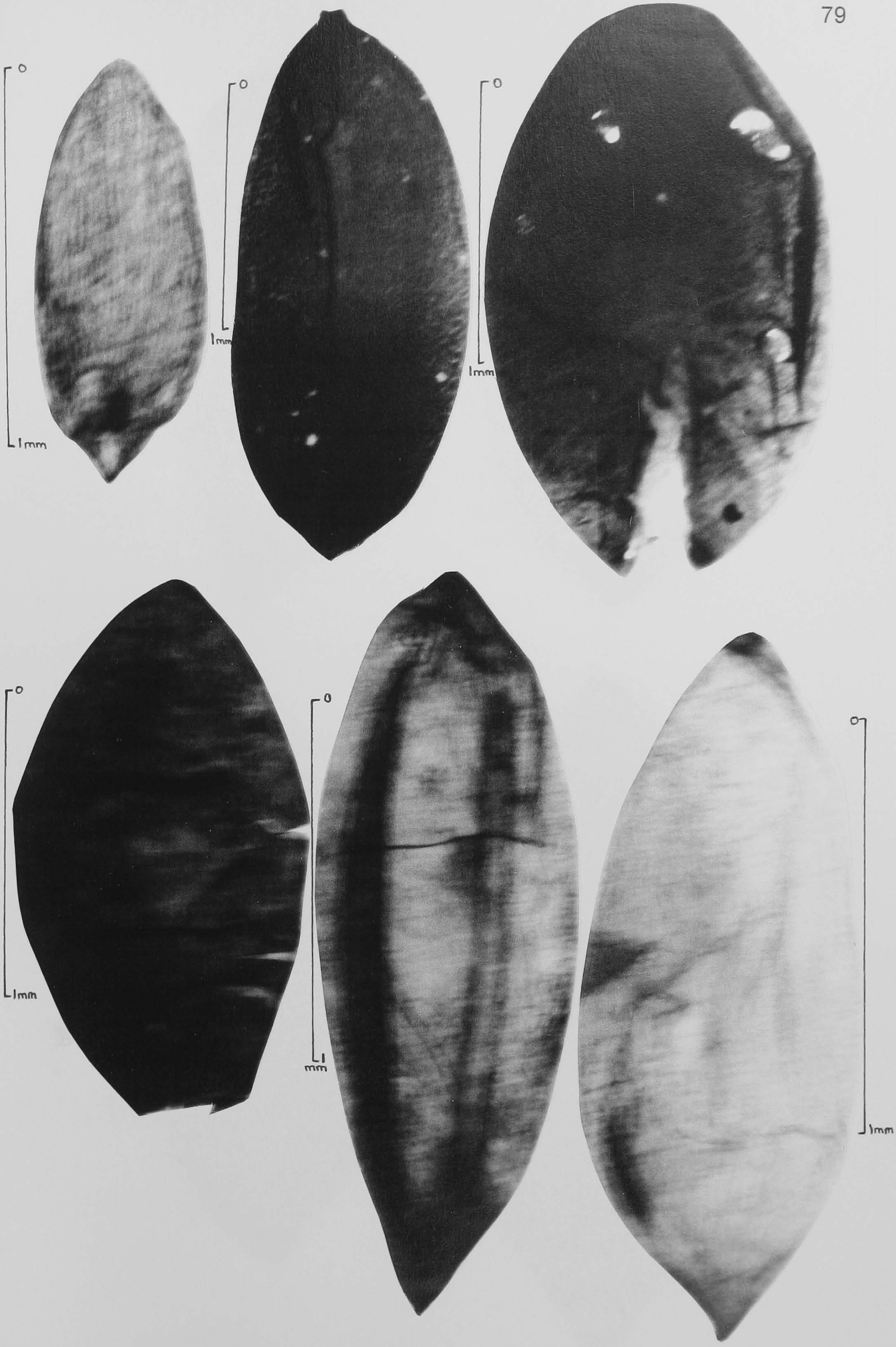


Figure 3.12. Small Poaceae other than *Poa* spp from Oakbank (top left *Agrostis* sp, *Glyceria fluitans*, *Danthonia decumbens* bottom left *Deschampsia cespitosa*, *Festuca* sp, *Holcus lanatus*)

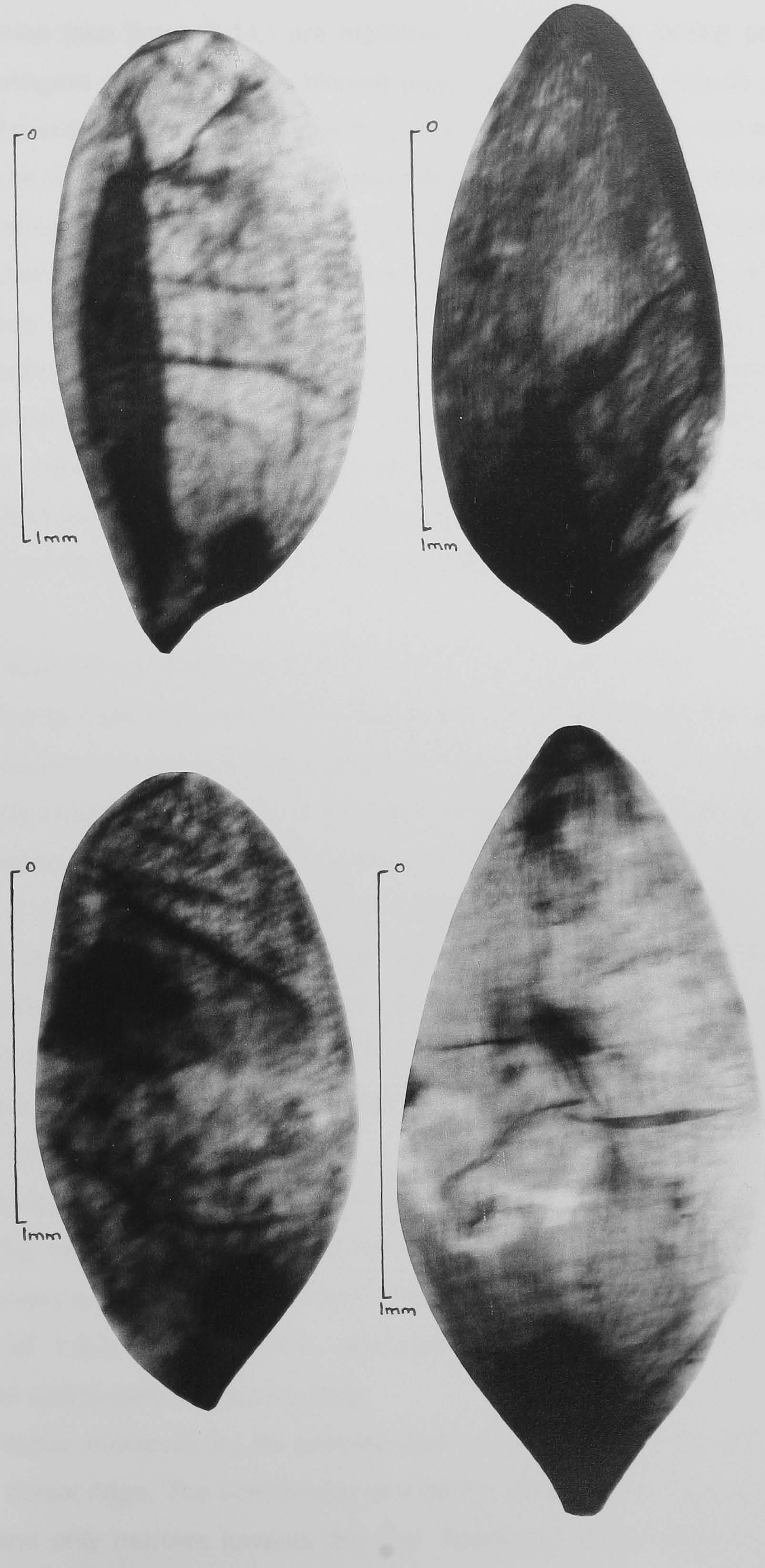


Figure 3.13. *Poa* spp from Oakbank samples (top left *P. annua, P. humilis,* bottom left *P. pratensis, P. trivialis*)

Cloudberries (see figure 3.14.) are montane plants with low fruiting potential and an obligate requirement for blanket peat above 700 feet altitude (Taylor 1971). The sorts of locations suitable for the growth of cloudberries are at some distance from the crannog site, and discovery of seeds there has implications for long-range human importation of the species onto the site. Cloudberries have a distinct seed (see figure 3.15) which is more similar in shape and testa morphology to a *Potentilla* species than other members of the genus *Rubus*. The smooth testa has a narrow ridge structure rather than a raised reticulum. However the very large size of the seed absolutely excludes any confusion with *Potentilla*. Seeds from Oakbank crannog were 4.0-4.3mm long x 2.5-2.9mm wide at the broadest point. The relevance of the discovery of this rare, montane species on a low altitude site will be discussed in chapter 5.

3.7.2. *Rubus idaeus* (Raspberry) and *R. fruticosus s.l.* (Bramble)

Separation of *Rubus idaeus* from *R. fruticosus s.l.* is problematic and can only be conclusive with well preserved remains at the lower end of the size range. Raspberry seeds are generally smaller than bramble, although there is overlap at the higher extent of the raspberry range. Size ranges are shown by Fredskild (1978). It is important to note that *R. fruticosus s.l* is an aggregate species which consists of several hundred apomictic races (Clapham *et al.* 1987), so it is variable with respect to seed shape and size. However, several characteristics assist in the separation of raspberry from bramble, principally the shape of the dorsal ridge and ventral scar, and the presence or absence of a 'beak' at one end.

Rubus idaeus has a noticeable beak and a low, relatively broad apical ridge. The ventral scar is broad at the point of joining to the receptacle, but narrows very quickly thereafter. Seeds from the reference collection were in the vicinity of 1.8-2.1mm x 1.5mm, although an occasional one was longer. Oakbank seeds were 1.7-2.2mm long.

Rubus fruticosus s.l by contrast has no prominent 'beak' and a high, narrow dorsal ridge. The ventral scar is wide for almost the entire length of the seed, and only narrows towards the end. Reference seeds were longer and generally wider than raspberry too (2.3-3.2mm x 1.5-2.2mm), although this was very variable. Oakbank material was 2.5-3.1mm long.

The characteristics outlined above assist in separating *Rubus idaeus* and *R. fruticosus s.l.* but are not always exclusive and must be treated with caution, especially in poorly preserved cases. Identification was considered absolute at Oakbank only at the mutually exclusive ends of the size ranges of the two types, and with almost entire, well preserved material.

Figure 3.14. Modern *Rubus chamaemorus* from Ben Lawers, Loch Tay.

Figure 3.15. *Rubus chamaemorus* seeds from Oakbank

CHAPTER 4: RESULTS

Results from each sample are shown in table 4.1 at the end of this chapter. This table is constructed in a manner which highlights the frequency of occurrence of individual species on the site as well as within each sample. Species are listed in alphabetical order and samples are grouped according to the area of site from which they were taken (see figure 1.3.). Figure 1.3. shows a plan of the Oakbank crannog site, marked off in 5m x 5m grid squares from A (1-8) to E (1-8) after Dixon (1984b). Areas of the site sampled for this study are shaded. Only area A3 has been excavated completely through the depth of matrix to loch bed level (Sands 1994). Table 4.1. also includes as one unit the aggregate sample 90A1/2GEN, a collection of manually selected large fruit-stones and nuts. Individual results for each sampling event in 90A1/2GEN are given in table 4.2. within the text

Samples for this study were taken from areas A1, A2, A3, B4, C1, C2, C6, D2 and E2, and are discussed chronologically for each location. Matrix composition, sample size and special treatments are noted. The archaeobotanical significance to the site of the samples within each context and of the area as a whole is reviewed. Context information for samples taken prior to 1994 in the course of the ongoing excavation is given where appropriate. However this data is not available for 1994 samples as they were not taken in the course of any excavation, but sampled from areas previously shown to have yielded good results which were accessible at the time. In this discussion propagules are generally referred to as 'seeds' for ease of comprehension. Relative abundances of matrix components are described alphabetically using terminology devised by Hubbard & Clapham (1992).

4.1. Areas A1 and A2

Two discrete samples and one large aggregate sample were taken from these areas, which adjoin each other at the north eastern edge of the organic mound, next to the entrance causeway.

4.1.1. Sample 90A1/A2GEN

This is an aggregate sample consisting mainly of nut shells and large fruit-stones with very little adherent detritus collected manually in the course of the excavation. Where *Corylus avellana* nut shell fragments are present, an attempt has been made to estimate the number of original nuts. This has been accomplished by arbitrarily designating entire status to shells which are more than ½ complete.

These samples have been classified during excavation in a different manner to the majority of others, with the day/month of excavation being an integral part, and no sample number being designated. They are discussed chronologically. Individual sampling event results are compiled in table 4.2. at the end of this description.

90A1 003 24/7

This sample had many fungal colonies in it, possibly resulting from a change of storage conditions. No adherent detritus was obtained for macro-fossil analysis. Context 003 is described as being a layer of small stones underlying the single layer of large boulders which originally covered the top of the crannog site (Dixon pers. comm.). This sample comprised 7 hazel nut fragments. These may have come from the occupation layer, but could also have filtered through the stones from another time period.

The loch margins around Oakbank crannog are straight sided and exposed to wave action, without any sheltered inlets to trap natural debris floating in the loch or encourage the growth of water plants. Therefore very little organic material of any kind settled on the crannog site between the successive summers of excavation compared to the large amounts washed up on shore at other points on the loch.

This suggests the broken hazel shells are perhaps not so likely to have come on to the site naturally, whether from consumption by animals or through natural germination. These reasons cannot be excluded, however, and this is a rare example for Oakbank of where the context is not confidently secure.

90A2 007 30/7

Described on site as "nuts and cherry stones". This sample comprised 12 *Corylus avellana* nut shells (one entire) and 2 *Prunus spinosa,* along with minimal detritus. fine examination of this revealed no other seeds. Context 007 is described as very fine organic material containing some bracken (Dixon pers. comm.). It underlies a layer of thick bracken (context 006, Dixon pers. comm.), and overlies a lens of sand/gravel similar to loch bed silt (context 008, Dixon pers. comm.). This may indicate a period of abandonment or intentional importation of sand for some unknown purpose. The organic silt in 007 may have dual origins from both the occupation levels above and the possible abandonment/imported sand phase. Consequently some or all of the macrofossils here may have had a natural or human influenced provenance.

10 *Corylus avellana* fragments found in the sample had a smashed appearance. One ½ shell was split longitudinally, and had the indentation of tooth marks in the centre, with small possible tooth marks at one end. Bang & Dahlstrom (1972) define this as being characteristic of the way squirrels open hazel nuts. This information would imply the shell was accidentally incorporated rather than collected for food. This could have occurred in one of three ways: naturally, and washed in; if the nuts were gathered non-selectively from a pile on the woodland floor; or if the nut was lying about on the crannog and was stolen by a rodent. The marks and straight longitudinal split may be coincidental, however, as it is possible, although not usual, to break open a nut in this way using a heavy object, and natural germination also results in this breakage pattern (Bang & Dahlstrom 1972).

90A2 007 31/7

This is another selective sample from the same context as the previous sample (context 007). It consisted mainly of broken hazel nuts. A small amount of indeterminate organic matrix was adherent to these. This was examined for plant macrofossils, and although few in number, the seeds found were comparable to those in occupation layers. This is likely to represent discarded household waste. Area A2 is adjacent to the causeway and entrance to the dwelling. It is likely that much household debris would have accumulated here.

90A2 007 6/8

This is another selectively picked sample of nut shells and fruit stones, many fragmentary, with an estimated 5cm^3 adherent mixed detritus. The majority of this is finely comminuted, and includes bone and charcoal fragments.

Matrix description:

bone (to 2mm)	co
charcoal (to 2mm)	ab
gravel	spa
insects	ra
seeds (any)	ra
vegetative remains	occ

2 hazel nuts have possible rodent damage. One is split longitudinally in the same manner as 90A2 007 30/7, indicative of squirrels (Bang & Dahlstrom 1972) or natural germination. As before this may be coincidental, but the other nut shows more convincing rodent damage, however. It is entire, except for a circular hole drilled in the side. The edge of this gap has eroded such that tooth marks are not present, but the positioning and size of the hole are characteristic of wood mouse attack (Bang & Dahlstrom 1972). This suggests either that the nuts were gathered in bulk without due care, or that since context 007 is above a lens of sandy gravel similar to loch bed silts then this sample may represent both household material and naturally occurring phenomena from either abandonment or sand importation.

15 of the total 33 *Prunus spinosa* fruit-stones retained adherent fruit-skin, to various degrees. Sloes become more palatable after frosting (Wiltshire 1992), and store well for winter consumption. Three *P. cf spinosa* fragments may represent grinding of the fruits in the same way that *Crataegus* species are made into cakes for storage. The size range of the sloe fruit-stones was great (7-10mm x 6-9mm) even though it is a very variable species, but they did not have the general appearance of bullace (*P. spinosa* ssp *insititia*) as described by Renfrew (1973), however, and were rather smaller than our reference

material. One *Triticum/Secale* bran fragment in with the fruit-stones suggests the possibility of sewage being present such as at Dundurn (Dickson & Brough 1989) but there is no way of proving this further here.

The presence of a living mite in the sample shows contamination but this is suspected to be from the water column rather than the sample itself, as this was selectively chosen from a matrix surface exposed immediately prior to sampling.

90A1 003 24/7	
7	*Corylus avellana* fgmts ~5 nuts
90A2 007 30/7	
12	*Corylus avellana* (1 entire, 10 fgmts ~size 1 LT split) ~9 nuts
2	*Prunus spinosa*
90A2 007 31/7	
2	*cf Agrostis* sp
1	*Carex* sp
34	*Corylus avellana* (32 fgmts)~18 nuts
1	*Galeopsis* subg *Galeopsis*
4	*Juncus effusus/conglomeratus*
1	*cf Poa* sp
3	*Urtica dioica*
90A2 007 6/8	
54	Corylus avellana fgmts (>37 nuts)
6	*C. avellana* entire nuts (1 charred, 2 immature, 2 with *cf* rodent damage)
~	insects (1 egg, 2 mites)(1 live contaminant)
10	*Juncus effusus/conglomeratus*
1	*Corylus* sp charcoal fgmt.
2	Poaceae (small)
3	*Prunus* cf *spinosa* fgmts
2	*Prunus padus*
35	*Prunus spinosa* (15 with fruit-skin + 2 fgmts)
1	*Triticum/Secale* sp pericarp fgmt.
2	*Urtica dioica*

Table 4.2. Results of individual sampling events in 90A1/2GEN

4.1.2. Sample 90A2S3 006

This sample consisted of a 2 litre container $^3/_4$ full of organic debris from context 006, filled to the top with loch water. 200 cm^3 displaced volume was subsampled. 006 is above the organic lens 007 where the previous A1/2GEN came from, and is the uppermost layer of organic material exposed following the removal of the boulder capping. This context represents secondary occupation (Dixon pers. comm.) and a pile within it was driven through a bowl from an earlier phase. The excavation plan revealed long lengths of hazel rods, which may have been stored for use in the dwelling.

Long *Pteridium aquilinum* fronds were observed in 90A2S3. The sample was almost entirely organic, with tiny charcoal and calcined bone present. Fine sieving obtained 50cm^3 settled volume of organic component. 9.6cm^3 settled volume was subsampled for *Juncus* spp seeds and the rest was scanned for anything new.

Matrix description:

calcined bone (to 3mm)	ra
charcoal (to 3mm)	ra
gravel to 10mm	ra
mosses	spa
organic detritus	ab
Pteridium pinnae	ab
Pteridium rachis to 150mm	co
seeds (any)	spa

The matrix contained large quantities of *Pteridium aquilinum* in the form of rachis fragments (to 150mm long) and numerous pinnae. Rachis was of a width commensurate with whole, relatively mature fronds and the probable use for this is for flooring material or bedding. The abundance of seeds mixed into the matrix makes floor material more likely, however. No sporangia were observed in this sample, and consequently the bracken was collected prior to the autumn. Very little wood remains of any sort were present.

Wild plant species in the matrix were frequent but individual numbers of each were generally low. They included seeds of species frequently found as crop weeds in arable assemblages. Bran of *Hordeum vulgare* and one *Triticum* *cf dicoccum* spikelet base remain from the processing of cereals, with *Anagallis cf arvensis, Bromus hordeaceus, Cerastium fontanum, Danthonia decumbens, Epilobium fontanum, Fallopia convolvulus, Galeopsis* subg *Galeopsis, Galium aparine, Lapsana communis, Plantago lanceolata, Ranunculus* spp, *Stellaria* spp and *Torilis cf japonica*. Many of these species recur time and again in samples containing cereal bran and chaff, and must have been prolific weeds. It is suspected that this assemblage represents a background level of cereal crop processing waste.

Carex spp present were varied in the habitats they represented, from damp grassland to acidic mire. Because of this it is not suggested that the sedges were part of the crop assemblage as van der Veen (1992) found, but were either incorporated with hay from damp and wet meadows, or were accidentally incorporated with flooring rushes. It is thought more likely that the long stemmed *Juncus* spp seeds in this matrix derive from flooring material rather than crop contamination of poorly drained fields as suggested by van der Veen (1992) due to their great abundance in the sample.

High numbers of *Prunella vulgaris* seeds, commonly known as self-heal, are higher than other possible crop contaminant/waste grassland species. Obviously 43 seeds could simply represent two or three fruiting heads, but similar numbers would then have been expected for many other species of a similar fruiting potential if this were the case. Other samples consistently also show higher numbers of self-heal than other potential crop contaminants. The dried flowering parts of this common herb were once used in folk medicine as an antiseptic and to stem blood from domestic accidents (Stuart 1989) which gave rise to one of its vernacular names 'the carpenter's herb'. It is possible that it may have been used for such a purpose at Oakbank. However this cannot be proven absolutely, and at any rate may not be the case in all samples.

Other wild species indicate mixed hay and fodder gathering. The 'hay' discussed here refers to wild grassland and waste ground species discussed by Greig (1984). It includes the grasses, sedges and dicotyledonous flowering plants which favour these localities including *Plantago* and *Ranunculus* spp, although it is recognised that some of the latter are found as crop weeds. Wood and wood margin species including *Carex sylvatica, Rumex sanguineus* and *Vaccinium myrtillus/vitis-idaea* show that this is a mixed assemblage. The *Vaccinium* may reflect consumption of this edible species, but could be chance incorporation from woodland localities.

4.1.3. Sample 94A2S5 (likely to be context 009)

This sample was taken directly, and not during the course of any excavation. It is thought to represent context 009, a woody organic layer containing broken pottery below 008, the lens of silty sand below 007. 007 is the context from which the general A1/2GEN came from. 94A2S5 is just under 2 litres of finely comminuted amorphous vegetative matter with round and flat wood, some with cut marks, and mature *Pteridium* rachis to *c.* 250mm. Some is charred. Numerous large wood chips are present with wide/long roundwood . Some have cut edges. Various broad worked fragments are angled, reminiscent of point-fashioning on a pile. One piece is spliced. Small twigs, both cut and snapped, charred bark, wood and charcoal are present. Some twigs have charred tips. Loch silt is mixed with organic debris. There is no apparent layering or striation.

The entire 2 litre sample was sieved due to the abundance of large roundwood mixed through the matrix, making subsampling problematic, and also the fact that samples from context area A have revealed interesting results. The total detritus examined after the removal of large wood etc. was 1.4 litre displaced. The total excluding the 150µm fraction was 1litre, of which more than half was fine silt. The silt compared well with that seen elsewhere on the loch bed and may have been deposited naturally from a phase of abandonment.

400cm^3 of the sieved matrix was subsampled for plant macrofossils. The results for this can be compared with other samples, as the high volume of natural silt was thought to bring the estimated amount of household detritus down to within the volume normally examined. Cereal fragments and mosses were extremely numerous although *Sphagnum* species leaves were rare.

Matrix description:

leaf debris (dicotyledonous)	spa
leaf/stem debris (monocotyledonous)	spa
moss	ab
Pteridium aquilinum pinnae	occ
Pteridium rachis	fq
seeds (any)	fq
twigs	co
wood (chips/round) all sizes	dom

The plant macrofossil remains from this sample are extremely interesting. A large proportion are food sources or weeds of crops, and species are present in fairly high numbers. Evidence of crops is in the form of seeds and capsule valves of *Linum usitatissimum* and pericarp fragments and chaff of *Hordeum vulgare, Triticum dicoccum* and *Triticum spelta.* Weeds of the cereals which are often found in close association at both Oakbank crannog and other sites were abundant in this sample. They include *Brassica rapa* ssp *campestris, Bromus* (including *B. hordeaceus*), *Cerastium fontanum, Chenopodium album, Fallopia convolvulus, Galeopsis* subg *Galeopsis, Lapsana communis, Persicaria lapathifolia, P. maculosa, Ranunculus repens, Rumex crispus, Sonchus asper* and *Stellaria media.* The majority of these were entire. *Chenopodium album* is notable here, with 165 seeds found. The fossil record frequently shows this species in crop assemblages and the nutritive value of the seed is well known (e.g. Helbaek 1950, 1958).

The high incidence of cereal chaff in this assemblage makes crop processing likely. This would account for some weed seeds being broken, if chaff was being pounded to release the grain, and is discussed in greater detail in the section dealing with crop processing. Processing of flax is indicated by the capsule valves and seeds found in the sample. Many of the capsule valves and seeds are broken, and they may have been pressed to release the oil. The high quality of oil and protein from *Linum usitatissimum* seeds make them a valuable food source. This has been recognised since the Neolithic (Bond & Hunter 1987).

High values for large weft-forming mosses including *Hylocomium splendens, Neckera complanata* and *Rhytidiadelphus squarrosus* could have been used for any number of household packing or wiping purposes, and since no recognisable coprolite material was recovered, human effluent may not be one of them in this context. The finely comminuted silt material present in the sample could have some relevance here though, since in part it could comprise digested food. However, no parasite eggs were seen when the silt material was scanned for this possibility. As mentioned above, it is likely that mosses were utilised for many purposes on the crannog, and their particular uses can only be guessed at by association.

No animal droppings were present in this sample and hay fodder is not well represented, although many species indicative of this maintain a low presence, including the various *Carex, Ranunculus* and Poaceae spp, *Plantago major* and *Torilis cf japonica.* These may have been added to flooring material along with wood margin and waste place indicators such as *Filipendula ulmaria, Heracleum sphondylium* and *Viola* spp. The *Carex* spp in the assemblage are varied in the habitats they represent, from damp grass to mire. None are abundant, however, and may be casual incorporation from various activities.

Gathered wild food species are present as low numbers of several species. These include *Corylus avellana, Prunus spinosa, Rosa* sp, *Rubus chamaemorus, R. idaeus, R. fruticosus s.l., Sorbus aucuparia, Fragaria vesca* and *Vaccinium myrtillus/vitis-idaea.* Their presence implies gathering for consumption and together with the cereal bran, hints at the suggestion of sewage. However bran fragments were larger than might be expected in fully processed cereals for human consumption. A2 is just inside the main entrance to the dwelling and may be where food processing occurred, along with the discard of household waste. Nevertheless, the presence of these nine wild fruit sources and cultivated crop assemblages highlights the range of foods gathered and grown by the occupants of the crannog.

Rubus chamaemorus and *Vaccinium myrtillus /vitis-idaea* in the same sample emphasises the long range gathering potential the community exploited. *Rubus chamaemorus* is montane in habitat with a lower altitude limit of 700m in the region (Taylor 1971). The berry is rare but palatable, and presence on the crannog of seeds has significance for human behaviour and perhaps transhumance. *Vaccinium myrtillus/vitis-idaea* is not thought to have had an abundant presence in the local woodland, and may have come from the hillsides of Breadalbane. Perhaps the two were gathered on the same expedition.

In this sample *Pteridium aquilinum* pinnae were uncommon compared to rachis fragments, some of which were very long and noticeably wide, suggestive of stems from mature bracken. It is suspected that the bracken in this sample may have been used for a purpose such as roofing rather than flooring material. Long, mature rachis denuded of frond material is described by Rymer (1976) and Fenton (1978) for thatch.

Wood chips of *Alnus* and roundwood of *Alnus* and *Betula* were prolific. A representative sample was analysed, but no other species were recovered and there was no significant difference in the appearance of the other wood fragments. It is likely they were all of these two species. Sands (1994) observed the abundance of cut wood chips produced by the fashioning of pile points, mortise joints and other similar activities. Wood chips here may have served a purpose to the household or may have been discarded with waste.

Scant charcoal was of *Corylus* and *Quercus.* This level is commensurate with accidental loss.

All plant species in this sample indicate summer or stored summer produce. Human faeces are suspected but this cannot be confirmed without resorting to coprosterol analysis.

The area A1/2 shows the discard of general household waste. The uppermost context, 006, comprises floor material but very little in the way of species directly attributable to foodstuff, apart from a few barley pericarp fragments. The majority of other seeds were intact, which suggests that no human effluent is contained in the sample from this context. Also no animal droppings were found, and consequently animal pen floor material is not suspected. Low numbers of many species indicative of crop assemblages suggest site processing of cereals. The organic lens of context 007 below 006 is mixed with sandy silt and may be mixed into the sand lens 008 below it. This possibly reflects importation of sand for whatever purpose or a period of abandonment on the crannog. There may have been a secondary building phase here, as suggested from site plans of the organisation of the timbers at this level.

The context of 94A2S5 is not totally understood, but is thought to represent 009, below the sand lens 008. It represents a period of much activity in the crannog. The processing of barley, emmer, spelt wheat and flax crops as well as gathered food species could have occurred here, and dumped household waste may be present. The discovery of a rough saddle quern in A2 (Dixon pers. comm.) is further suggestive of the role of this area in food processing. The almost non-existent evidence for rushes and few bracken pinnae suggests that occupation floor material may not form a big part of this assemblage. The specific collection of individual species with known uses is suggested by the frequent occurrence of plants such as *Prunella vulgaris* and *Urtica dioica.* (see chapter 7). However both these species are common in the locality and may have been incorporated accidentally sometimes too.

4.2. Area A3

Area A3 is the point at which the causeway joins the main mound and is adjacent to A2. A3 is the only square from the site which has been excavated to loch bed level (Sands 1994), and shows at least five phases of construction or consolidation (Dixon pers. comm.). It represents the entrance foyer to the crannog, and shows a complicated array of piles from various stages overlying each other. The collapse of a secondary floor here caused the mound to slump outwards, and interesting finds including a wooden dish, canoe paddle and spoon have come from this slope. One sample was analysed from this area. Results compare well with those from area A2.

4.2.1. Sample 81A3S4 4c/d

Context 4c/d was described using the first terminology of the site, where context '4' was the organic mound, and stratigraphic units were lettered alphabetically. This was later changed to the three digit numerical one employed in later excavations of the site. 4c/d is deep into the organic material and represents an intermediate phase within one of the lower construction layers found here. Sample 81A3S4 was taken from a location close to the innermost causeway piles shown in the site plan, figure 1.3.

81A3S4 was a 2 litre box sample from which 200cm^3 displaced volume was subsampled. The matrix was in the form of a hard, solid mass, in which large wood was common, still retaining bark. Small wood, charcoal and broken fern rachis were also present. The surface of the mass was smooth, almost shiny, possibly eroded. The compressed nature of the sample was not in keeping with others examined in this investigation.

One large piece of quartz schist was observed circa 10mm diameter, but no other inorganic material was observed. No stratification was seen in the matrix. Sieving obtained 62cm^3 volume of 150μm diameter material, from which 20cm^3 was subsampled.

Matrix description:

insects	ra
monocotyledonous stem	occ
moss	co
Pteridium aquilinum pinnae	fq
Pteridium aquilinum rachis	fq
seeds (any)	occ
twigs	co
wood cut/broken	ab

Area A3 is likely to have had similar household traffic to A2. Analysis of the wood in this sample revealed that all roundwood fragments were *Corylus.* The width and age of these as indicated by the number of growth rings is suggestive of the remains of wattle. Three worked wood chips were *Alnus*. As the majority of structural timbers and domestic artefacts are alder, the fragments could have had any provenance. Charcoal fragments present were also alder and hazel. Mosses were common and various species were present. Only those used by people were identified due to constraints on time, but small species with purely ecological implications were never frequent by comparison. *Hylocomium splendens, Hypnum cupressiforme* and *Neckera complanata* were all present in significant amounts. These large weft-forming species have different ecological habitats which concurs with the theory of specific collection. In this instance the association with frequent hazel roundwood fragments suggests wind-proofing of cracks in hurdle walls.

The macrofossil evidence from seeds reveals low numbers of several edible species, both gathered wild fruits, hazel nuts and cereals. Broken *Rubus idaeus/fruticosus* pips and bran of *Hordeum* and *Triticum/Secale* species may be from sewage, but not necessarily. As was the case in samples from A2, no direct evidence of any coprolite material was found in this sample. Nevertheless the possibility exists that sewage is present here.

Species often found as contaminants of cereal crops are frequent and varied in this assemblage, including *Avena* sp, *Brassica rapa* ssp *campestris, Bromus hordeaceus, Cerastium fontanum, Chenopodium album, Fallopia convolvulus, Galeopsis* subg *Galeopsis, Galium aparine, Lapsana communis, Persicaria lapathifolia, P. maculosa, Plantago lanceolata, Prunella vulgaris, Sonchus asper, Spergula arvensis* and *Stellaria media*. The majority of these seeds were unbroken. Wild species indicative of hay from various habitats include *Agrostis* and *Carex* species, *Deschampsia cespitosa, Linum catharticum, Poa pratensis* and *Ranunculus* species. Monocotyledonous stem fragments were not sufficiently preserved to be identifiable but by association they are likely to be from the Poaceae or Cyperaceae. *Juncus effusus/conglomeratus* seeds suggest rushes strewn on the floor. Wild flowers such as *Filipendula ulmaria* may have been intentionally added too.

The presence of alder and hazel catkins which mature in the very earliest spring does not correspond with the seed evidence, much of which implies late summer. The catkins are initiated in late summer but do not open to release pollen until the early spring of the following year. Pollen identified from these catkins was mature and recognisable, and they are believed to have been fairly ripe at time of incorporation into the matrix. This would imply occupation of the crannog during the late winter/early spring. However, seeds of *Fragaria vesca, Rubus idaeus* and *R. fruticosus s.l.* are produced in the late summer months, and are most likely to have been consumed directly. It is suspected that this mixed assemblage may show the build up of discarded household waste over a protracted period such as the autumn and winter months, incorporating some stored produce. Insect fragments are rare, suggesting deposition in the colder months, or frequent renewal of flooring materials. The high values for crop weeds suggests processing on site. Perhaps this was done at the doorway to increase the available light and save carrying it unnecessarily through the house.

Bracken, hay, rushes and possibly straw with occasional wild species accidentally incorporated would have come from floor deposits. Bracken pinnae do not show sporangia and may have been collected prior to the autumn. Large pinnules are more suggestive of semi-mature fronds than young emergent spring croziers.

4.3. Area B4

One sample from this area was taken for study. B4 is within the central portion of the main mound and represents part of the habitation area. Partial remains of a floor level were found here (Sands 1994). Site plans show an abundance of small diameter oak rods, small uprights and structures. It may have been reconstructed separately from other areas, or may represent internal divisions.

4.3.1. Sample 94B4S8

This is a 2 litre sample, 80% full, with 2 distinct bedding planes. The top layer (lens 1) consists of large roundwood , estimated 7-8 years old, 30mm diameter, with smaller roundwood and bark fragments to 10cm long in the organic matrix. Charcoal to 30mm long is present. The bottom layer (lens 2) includes 30mm of loch bed silt into which roundwood *circa* 10mm diameter is embedded by compression. *Pteridium aquilinum* rachis to 100mm long is occasional. 2 separate subsamples were removed for analysis. Lens 1 was 200cm^3 displaced volume. This was almost entirely organic. Lens 2 was 400cm^3, including large roundwood . When the wood was removed the volume of substrate left was approximately similar to lens 1. This was highly inorganic.

Matrix description: lens 1

bark fgmts to 5mm	ra
bone	ra
charcoal to 30mm	occ
cf charcoal dust	co
gravel to 2mm	ra
insects	occ
moss	occ
Pteridium aquilinum pinnae	occ-fq
Pteridium aquilinum rachis to 60mm (mainly<10mm)	fq
sand	occ
seeds (any)	spa
wood (round) to180mm. Includes small twigs	occ
wood fgmts to 5mm	fq

28cm^3 displaced volume was retained on the 150μm sieve, which was approximately 70% organic, mixed with micaceous sand. 3½cm^3 of this was subsampled. It proved to be extremely rich in *Juncus* spp seeds.

The macrofossil evidence from lens 1 provided evidence of several species of wood, both as roundwood and cut chips. *Corylus* and possibly *Betula* found could be from wattle construction, but roundwood of *Alnus* and *Quercus* species suggest another use. Small diameter oak rods of some length were abundant on the site plans, and may have been from some internal division or stored for some indeterminate household use, for example peg-making. Pegs would have been extensively used in the construction of the crannog. Alder roundwood cannot be assigned a specific use due to the abundance of the species in general on the site. Worked wood chips and occasional charcoal attest to household activities.

Remains of bracken in this upper lens are frequent but the fragment size is generally very small. This is indicative of winter collection when the fronds have dried and fallen over. This may have been used as bedding for animals or people, or for packing. This latter suggestion is not so likely, however, as the evidence for mosses is extremely poor in this sample, and mosses are often indicative of packing material.

Remains of gathered wild food plants are not common in this sample, and cereal crop assemblages consist mostly of weed seeds and chaff remains, with very small amounts of cereal pericarp. This association, together with the comparatively high occurrence of grassland and waste place indicator species and a few ovicaprid droppings, would suggest the possibility of animal husbandry in this area. This further suggests that the roundwood found within the area might have formed some sort of animal enclosure. High values for *Juncus effusus/conglomeratus* seeds could be from fodder or crop waste (van der Veen 1992), but here is more likely to indicate rush flooring. *Juncus bufonius* is not included in this conclusion, however, due to the short stature of the stems. This species may have come in on muddy boots or hooves from a wet track-way or accidentally with other species.

Matrix description: lens 2

bark fgmts	occ
bone	ra
charcoal	occ
gravel to 20mm	ab
moss	ra
Pteridium aquilinum pinnae	ra
Pteridium rachis to 80mm	ra
roundwood to 60mm	ra
seeds (any)	ra
twigs to 10mm	ra
organic detritus	fq

This sub sample is highly inorganic, with occupation debris mixed through. 125cm^3 settled on the 150µm sieve. 94 cm^3 of this was pure mica sand. The fraction above this was mixed organic/sand, approximately 40% organic. 4 cm^3 volume was scrutinised for seeds. The basal sand below this was quickly scanned, but contained nothing organic.

The macrofossil evidence from lens 2 is similar to that of lens 1, although there are fewer species, and it is somewhat less organic. It is likely to represent sandy clay or debris from the large micaceous stones which were found dispersed through the organic contexts of this area of the site (Dixon pers. comm.). These are not explained but may be from a hearth which has collapsed somewhere nearby.

4.4. Area C1

Three samples were taken from this area for study. Area C1 is at the eastern perimeter of the mound, behind B1. It is likely to represent in part the outer perimeter and walls of the dwelling. There has been some subsidence of this area, and the piles and branches present a complicated site plan indicating collapsed floor areas. The frequent charcoal and burnt wood scattered throughout the slope of this area suggests a hearth in the vicinity has also slipped.

4.4.1. Sample 91C1S5 019

Context 019 is an organic layer underlying a lens of silt and small stones and may be equivalent to 004, the top of the organic mound in areas C2 and C3 (Dixon pers. comm.). This would put 91C1S5 into part of the last remaining phase of occupation before the boulder capping. The sample was taken from the edge of the C1:B1 interface, and consisted of a large sealed bag containing extremely disaggregated organic detritus in water. A layer of fine sand was present at the bottom of this, with mica and small gravel mixed into it. It was impossible to subsample a displaced volume of this thick “slurry”, so 300cm^3 volume was examined. This was judged to approximate to the standard 200cm^3 displaced. The sample contained very abundant small, simple rootlets which were unbranched. These invaded everything, including seed fragments, and were entwined around wood and into clumps of monocotyledonous grass/sedge stem tissue. The small amount of material settled on the 150µm sieve was examined for small seeds in its entirety. This was approximately 10cm^3.

Matrix description:

Charcoal to3mm	ra
insects	spa
monocotyledonous culm epidermis, *cf* straw	fq
mosses (low growing spp)	occ
Pteridium aquilinum pinnae (many sporangia)	fq
Pteridium aquilinum rachis	occ
rootlets unbranched.	ab
sand/small gravel	fq

seeds (any)	spa
vegetative detritus	fq
wood (to 5mm, some charred)	occ

This sample contains many bracken pinnae complete with sporangia, but few rachis fragments. This is more suggestive of flooring or bedding material than any other purpose. The presence of sporangia implies early autumn collection. *Juncus articulatus/acutiflorus* type rushes may have had a similar use to bracken. The few seeds of *J. effusus/conglomeratus* do not necessarily mean that less of these rush types were collected.

Other macrofossils indicate the same general mix of wild grassland species seen in other samples. No cereal remains are present however, and cereal crop contaminants are also scarce such that supplemented hay fodder is not suspected. The sample is very disaggregated and consequently has a mixed assemblage. It may represent various household uses. The low numbers of seeds of individual species makes explaining contexts harder to achieve, although interestingly seeds of *Sagina* spp were numerous by comparison with other species. The pearlworts are tiny, and their low stature suggests they may have been incorporated with turf from grassy areas, rather than in hay.

Many of the other species present grow in grassland or open woods. *Selaginella selaginoides* megaspores suggest collection from upland areas, but lowland damp grassy areas and open woods are also indicated. Turf collected from various areas might be represented here in part, either from underthatch or as a result of consolidation of the mound now present underneath it prior to a further construction phase. The abundant fine rootlets invading all other remains also suggests the possibility of abandonment above water level for a period. The low numbers of other macrofossils and consistency of the sample means further specific context descriptions are not possible. However, a sleeping area might be suggested from the general lack of edible species, frequent crushed bracken, and background levels of wild species in with the suspected flooring material.

4.4.2. Sample 91C1S6 021

Context 021 is underneath the silt lens 020 immediately below the uppermost organic layer 019, from which the previous sample was taken. Like 91C1S5, sample 91C1S6 was taken from near the C1:B1 interface. It consists of the contents of a twisted twig knot (SF25), of the kind used to join hurdles, for example. The material appeared paler and denser than the surrounding matrix during excavation (Dixon pers. comm.). Context 021 is immediately below a narrow silt lens 020 which underlies the organic layer 019, that 91C1S5 was taken from (Dixon pers. comm.).

As mentioned above, area C1 is on the more exposed side of the site, with a high degree of turbulence and water agitation. It has subsided in antiquity, with a fairly steep angle, such that finds from here are a widespread mixture resultant from the collapse.

150cm^3 displaced volume was subsampled from a total 250cm^3. Very little substrate settled on the 150µm sieve, and this was examined in its entirety for small seeds.

Matrix description:

charcoal to 3mm	spa
fungal hyphae	ra
gravel to 5mm	spa
Monocotyledonous stem epidermis/culm nodes	ra
Pteridium aquilinum pinnae (some + sporangia)	fq
Pteridium aquilinum rachis, to 150mm (mainly<50mm)	co
sand/gravel to 3mm	occ
seeds (any)	spa
wood (worked/round)	spa

Due to the collapse of C1 this sample will be a mixed assemblage like 91C1S5, but still shows some interesting features. *Hordeum* and *Triticum* caryopses and processing waste are frequent, and species which are regularly found in association with them at Oakbank are also present, including *Bromus* sp, *Lapsana communis, Ranunculus* spp, *Sagina* spp, *Sonchus asper* and *Stellaria media*, with *Rhinanthus minor,* small Poaceae, *Carex* spp and a flower of *Trifolium repens*. This makes cereal processing waste and hay fodder likely.

The presence of seeds of the low growing *Sagina procumbens* suggests this was cut close to the ground. This assemblage suggests a totally different provenance to 91C1S5. Evidence from 91C6 might represent slippage from B1 and A1 where there is evidence of crop processing having occurred. However, it may simply highlight the individual nature of each sample, and shows caution is necessary when attempting to designate specificity of use to areas.

Bracken pinnae from this sample have retained sporangia and consequently were gathered in late summer or early autumn. One fragment of Pomoideae (*cf Sorbus* sp) wood reflects small scale specific collection. Sands (1994) demonstrates the low abundance of *Sorbus* wood at Oakbank. Other occasional seeds show casual loss from undefined household activities.

4.4.3. Sample 91C1S8 025

Context 025 was described during excavation as "sawdust-like" in composition. It lies below context 022 with lenses of sandy gravel between (Dixon pers. comm.). Compaction has given this sample a hardened appearance. It was a large, flattened mass which was split into 2 relatively distinct bedding planes. The top plane was obvious from the orientation of the ubiquitous *Pteridium aquilinum* rachis, identified by association with pinnae. This was at an angle of about 60^0 to the rachis in the lower plane. $^1/_3$ of the entire lump was studied in detail, with initial disaggregation being facilitated using low power microscopy. This gave a displaced volume of almost $250cm^3$.

Matrix description:

charcoal	ra
dicotyledonous leaf detritus	fq
dicotyledonous leaf, entire	spa
gravel to 2mm	spa
insects	ra
monocotyledonous stem cf Cyperaceae/Poaceae	fq
moss	ra
Pteridium aquilinum pinnae	co
Pteridium aquilinum rachis (mature)	ab
seeds (any)	ra
vegetative detritus	fq
wood (small worked chips)	fq

Analysis revealed there was no difference in the make up of the two planes, nor any dividing lens markers such as silt. Very little inorganic material of any description was found. Entire and fragmentary leaves of *Corylus* and *Alnus* were present, and short lengths of bracken had pinnae extant, although the majority were broken off. Nevertheless it was clear from this initial sorting that long lengths of mature *Pteridium aquilinum* fronds were lying in parallel orientations as if they had been initially gathered or stored in bundles prior to deposition. The presence of pinnae would suggest the intention for use as flooring or bedding rather than thatching (Rymer 1976), or alternatively bundles may have been awaiting further processing and pinnae removal for thatching. The organised condition of the bracken suggests storage as bedding and laid flooring material would be haphazard.

Small wood fragments and leaf detritus highlight wood-working waste in the vicinity. The frequent occurrence of Cyperaceae/Poaceae stem fragments in very poor condition and the *Carex* and *Poa* species seeds found could be relevant as grassland fodder. Seeds of *Bromus hordeaceus, Chenopodium album* and Polygonaceae could also be explained as animal feed from arable waste, although the latter two are also opportunists. *Hordeum* species fragments and entire caryopses may have been fed to livestock, or may have been simply lost during processing for human consumption. This is also true for the *Linum usitatissimum* found. Large weft-forming mosses are present in moderate quantities and may be from packing in wall material or other household purposes. There is no indication of faeces in this sample.

In general samples from area C1 have shown a mixture of household activities including cereal crop processing and potential storage of both fodder and roofing/flooring/bedding materials. The uppermost context 019 has evidence which may be indicative of turf. This could have been the remains of underthatch from the last remaining structure, or might have served to consolidate the mound prior to construction of another which no longer exists. No coprolites of any description were found in area C1 and it is unlikely that animals were kept there.

4.5. Area C2

Area C2 is adjacent to C1, but further into the main organic mound. Like C1 it is to the deep water side and has experienced extreme slippage in antiquity. C2 is on a very steep slope. Site excavation plans show collapsed floors overlain with structural uprights. As with C1, a charcoal scatter seen throughout the excavation indicates a collapsed hearth nearby. The sample analysed is from context 022. This is deeper into the organic mound than 021, the organic layer in C1-C2 from which sample 91C1S6 was taken (Dixon pers. comm.). Site plans indicate remains of a walkway around the main dwelling in this location. The stratigraphy is confused, however, due to the subsidence of the area. This slippage is so steep that it may have been catastrophic in antiquity (Dixon pers. comm.).

4.5.1. Sample 91C2S7 022

The sample was described by the excavators as a “dungy, compact ashy layer”. It consisted of approximately 750cm^3 displaced volume, in large masses, with 70mm incorporated. 1 piece of quartz 40 x 30mm was also present. The sample was compacted into flattened thick plates, and hard, which necessitated the sub-sampling of several aggregations to a total volume of 250cm^3. This was rather more than usual, but was unavoidable.

The concretions were difficult to disaggregate, but a combination of soaking in warm water and separation under the dissecting microscope achieved this. Two of the biggest lumps required soaking in 0.5% NaOH for 1 hour. This had the desired effect with manual assistance, and several ovicaprid (sheep/goat) droppings were removed from the matrix. However, when the droppings were placed in water, this instantly became dark and opaque. This cloudiness recurred every time the water was changed, and is thought to be due to the NaOH altering the stability of the organic remains. As this effect hinders close examination, samples will not be subjected to this treatment again.

Matrix description:

charcoal to 30mm (mostly <5mm)	fq
organic detritus	co
gravel to 10mm	ra
insects	ra
monocotyledonous stem epidermis	co
mosses	ra
ovicaprid droppings	occ
Pteridium aquilinum pinnae (finely broken)	occ
Pteridium aquilinum rachis (to 50mm)	co
sand	ra
seeds (any)	spa
wood (any, some charred)	co

Some of the lumps of matrix analysed showed slight evidence of charring at the edges. Bracken was present as short lengths of rachis and broken pinnae fragments. This suggests dry incorporation, possibly intended for tinder. Some rachis fragments were charred. The sample contained much monocotyledonous stem epidermis, some of which is present in clumps. These aggregations were of grass and sedge type stem, but cannot be further identified due to poor preservation They were well compressed and hard to separate. Several were wrapped around wood. One aggregation of stem tissue was partially charred. This implies that it was dry when incorporated into the matrix, and further suggests tinder or fuel. Two charred *Lapsana communis* and small charcoal were the only further indicators of a fire in this vicinity, however. As mentioned above, the hearth may have been somewhere nearby but not immediately adjacent to this part of C2. Excavations to date have not been able to confirm the location of any hearth, although the general charcoal scatter confirms the presence of one.

The occasional presence of droppings, and the general appearance of many other components of the sample is reminiscent of animal pen flooring material mixed with mixed fodder. Rushes, straw and bracken are likely to have been the main floor components throughout the crannog, and were probably used to stall animals too. Wood fragments, some very small and eroded, were present in this sample and may have contributed to floor material or been used as tinder.

The sample contains species from various and very different habitats, including arable crops and their weed assemblages, woodland fruits, waste ground species and indicators of drier and wet grassland. Seven *Carex* spp were identified which further indicate mixed habitats. *Carex pilulifera* and *C. ovalis* grow in barely damp grass whereas *C. echinata, C. hostiana, C. nigra* and *C. panicea* grow in wet flushes and marsh. The combination of these different habitat assemblages and their respective components together with ovicaprid droppings implies that it reflects fodder in the form of low cut hay from various types of habitat, to which cereal and flax processing waste has been added. This last is in the form of heavy and lighter chaff, contaminant weeds and accidentally lost crop seeds. The occasional *Rubus idaeus* and *R. fruticosus s.l.* reflect casual loss of gathered wild fruit.

The compacted appearance of this sample implies the inclusion of moderately dried animal pen material. Fenton (1978) discusses the use of dung as fuel in Orkney until recently. The location of this sample suggests that animals might have been housed on the walkway surrounding the dwelling. The partially charred nature of some other components in the matrix suggests their possible intention as fuel. This is thought to be a mixed sample, however, and may include other general floor material.

4.6. Area C6

Seven samples were taken for analysis from area C6. This square forms part of the south west extension and has been most extensively studied with respect structural components. It was built in a single constructional episode (Sands 1994). Whether the two mounds were contemporary, and the purpose of the smaller area, remains unclear. However, the fact that the organic mound of the extension extends underneath that of the larger mound (Dixon pers. comm.) implies that it either predates it or is at least contemporary with the initial free standing pile construction of the main mound. Three samples were analysed initially and proved very rich in plant macrofossils. These were taken in the course of excavation and their contexts are known. A further four samples from this area obtained by the author in 1994 were not taken during excavation and consequently their contextual relationship is not known.

4.6.1. Sample 87C6S1 4b

Context 4b is approximately 5cm from the top of the organic mound, and consequently is one of the latest phases of the site. 87C6S1 is a 2 litre sample which is approximately 90% organic and very finely divided in composition. 200cm^3 displaced volume was subsampled as before. This was approximately 90% organic and contained a great deal of unidentifiable detritus. Charcoal was frequent and small burnt bone fragments were noticed. Seeds were varied and numerous, mixed with bracken rachis and animal droppings. 115cm^3 displaced volume of finely comminuted detritus was obtained on the 150µm sieve. 5cm^3 volume of this was closely examined, and the rest scanned.

Matrix description:

cancellous bone to 3mm	ra
charcoal to 15mm	fq
gravel (<2mm)	occ
gravel/schist to 170mm	ra
mosses	ra
ovicaprid droppings	occ
Pteridium aquilinum rachis (broken)	occ
seeds (any)	fq
indet. organic detritus (finely comminuted)	co
wood/worked wood ± bark to 75mm	spa

The assemblage is of very mixed origin, in terms of species, ecology and times of year represented. Early spring is indicated from an *Alnus glutinosa* inflorescence, recognised by its pollen. Potential late autumn or winter food sources such as hazel nuts are present too, and also fruit stones of *Prunus spinosa,* which dry well for winter consumption. The storage of crop and hay assemblages could account for their presence in this sample alongside indicators of spring, but seeds of *Rubus chamaemorus, R. cf idaeus* and *R. fruticosus* imply collection in July and August. It is suspected that either the floor has not been cleared over the autumn-winter period or that mixing of the matrix material occurred prior to or during collection.

In terms of both number of species and individuals, this is an extremely rich sample. Trees represented include *Alnus, Betula, Corylus, Quercus* and *Ulmus,* the latter two being present as charcoal. 2% of the structural timbers at Oakbank are *Ulmus* (Sands 1994) reflecting its occasional presence in the area. One charred *Hordeum* sp grain was also observed. This sample contained 3.23g of charcoal, more than the majority of samples examined, but still a very low level by the standards of other excavations. Clapham & Scaife (1988) found a similar situation. A scatter of charred material has been observed during the excavation, but was never extensive (Dixon pers. comm.). As observed previously, this suggests that there was not a hearth in the vicinity to the samples taken. It also highlights the fact that if this site were not waterlogged, little botanical evidence other than this scant charcoal would have survived from these samples. As the site has only been 25% excavated (Sands 1994) it is likely that the hearth site will be uncovered in the future.

Occasional ovicaprid droppings were present in the sample. One of these contained fragments of *Rubus fruticosus s.l.* seeds. Many of the droppings were fragmentary and could not reliably be distinguished between sheep and goats. The plant macrofossil evidence shows an abundance of species which grow as crop contaminants or in wood margins and waste places, as in other previous samples. Cereal processing waste is abundant in this sample along with hay assemblages, rush seeds and bracken remains. Hay fodder indicators found include species of *Carex*, Poaceae and wild plants suggestive of wet and drier areas of grassland and open woods. As in previous cases, this assemblage suggests animal husbandry with sheep or goats fed hay from damp meadows supplemented with cereal crop contaminants and chaff. Field and wood margin species are included in this fodder, and tail grain with a little prime barley may have been added to increase the nutritive value. The scant evidence of wheat bran compared to barley may be due to the greater value laid on this cereal, or the wheat may simply have been better threshed.

The moss evidence is very slight from this sample, but *Hylocomium splendens* and *Neckera complanata* are indicated which could have been used for a variety of purposes. Rush seeds are frequent, and rushes may have been collected for flooring, lamp making, or to repair thatch. As mentioned previously, the possibility of rushes as crop contaminants is recognised, but not thought important here. *Juncus effusus/conglomeratus* (undifferentiated) initially seems to be more common than *J. articulatus/acutiflorus* (undifferentiated), but this is not necessarily relevant due to the vast numbers of seeds rushes produce. Both types are common in the area and have similar anthropogenic uses, so little emphasis can put on this difference in seed number. As in other samples, the two *Juncus* types were not further differentiated between due to constraints on time and the little additional information that making the distinction would provide, in terms of ecology and human use.

4.6.2. Sample 87C6S5 4b

This is a small sample only, filling a 227g container. 100cm^3 displaced volume was taken for analysis. The sample appears to be mainly composed of finely comminuted organic material. Larger pieces of wood and fern rachis are noticed, also droppings and smaller wood. No stratification was observed. This is a wet, loose sample. 27cm^3 displaced volume was settled on the 150µm sieve, of which 5cm^3 of this was subsampled. This contained 56 *Juncus* spp seeds.

Matrix description:

charcoal	spa
fungal hyphae	fq
moss	ra
ovicaprid droppings	spa
Pteridium aquilinum pinnae	fq
Pteridium aquilinum rachis	fq
seeds (any)	occ
tiny wood fragments,to3mm	co
uncut wood ± bark to 25mm	fq
vegetative detritus	spa
worked wood to 25mm	fq

This sample was also from context 4b but was smaller and less diverse than 87C6S1. Nevertheless it showed a similar general picture of animal husbandry and fodder comprising cereal chaff, crop contaminants and mixed hay. Flooring material consisted of large bracken fronds and rushes. There was also evidence of poorly preserved monocotyledonous stem tissue, possibly from straw or hay. As before, the *Carex* species indicate grassland of various kinds, and there is a diverse wild plant list. two *Arctium lappa/minus* seeds found here were the only evidence for greater/lesser burdock on the site. This could have been collected for the plants' large leaves to use as fodder or wrap food, or the stems might have been collected to flavour drink, but the seeds could just as easily have been brought into the house unintentionally.

There is very slight evidence of heather in this sample. *Calluna vulgaris* capsule valves and leaves could be from heathy turf (with *Carex* spp) or the specific collection of heather for rope or other small scale purposes. This is thought more likely when compared with the rest of the assemblage and the complete absence of *Carex* rhizomes at Oakbank. Thatching with heather is not indicated as only low levels of the species were found throughout the site.

4.6.3. Sample 87C6S6 4b

This sample was layered and compacted with no variation between lenses. A faint methane smell was observed. The matrix was well comminuted, with droppings, worked wood chips, bracken rachis fragments and small charcoal. 200cm^3 displaced volume was analysed from approximately 1 litre total volume. Sieving showed that over 90% of the sample is degraded plant material. 20cm^3 of 150µm material was subsampled from 38cm^3 displaced volume.

Matrix description:

charcoal <5mm	fq
charcoal >5mm	spa
mosses	ra
Pteridium aquilinum rachis (<50mm)	occ
seeds (any)	fq
Pteridium aquilinum pinnae fragments	co
tiny stem fragments	co
tiny wood chips	fq
twigs.	ra
wood chips >10mm	ra

The plant macrofossil results for this sample are entirely similar to those from the other two samples from context 4b, suggesting that they are of a similar origin. Variation in numbers of species and individuals can be explained by the difference in sample size and chance occurrence. In this sample two *Papaver somniferum s.s.* seeds were identified. Their morphology and size distinguishes them from the wild *Papaver somniferum* ssp *setigerum* (see chapter 3). The discovery of opium poppy seeds in this Late Bronze/Early Iron Age settlement is significant as the earliest of its kind in Scotland, and has implications for trade. It is not suspected that the opium poppies were crop contaminants, as their capsule size is very large and is also seed retentive. The seeds found here are too few to signify use, but small scale cultivation for oil or flavouring food is envisaged. This is discussed more fully in chapter 7.

Other points to note here are the large numbers of crop contaminant weed seeds, the species of which keep recurring in the different samples in context 4b. They are always found in close association with bran fragments of *Hordeum vulgaris* and *Triticum dicoccum* and *T. spelta* chaff, but not frequently or abundant in other samples not containing cereal waste. The same is true for the grassland assemblages, which are also repetitive in composition. These are most frequently seen together in samples containing ovicaprid droppings, and must signify fodder. It is possible that crop waste such as this could signify famine food from failed crops or late winter consumption, but it is notable that all these assemblages contain wheat chaff but very few wheat bran fragments, which appear to have been carefully removed for human consumption. The association of cereal chaff with hay and animal droppings makes fodder more likely, as suggested previously.

Individual species within this assemblage which are also waste or grassland indicators may have been selected for specific purposes. This includes *Prunella vulgaris* for its medicinal properties and *Urtica dioica* for food or fibre. The use of nettles as famine food for the poor in 19th Century Ireland is discussed by Lucas (1959). However, there is no direct evidence here for the specific use of any of these species.

4.6.4. Sample 94C6S1

This is the first of the 1994 C6 samples which cannot be compared by context. 94C6S1 was a bag sample taken from a narrow black layer within the organic matrix. It is small, *c.*150cm^3 volume, with a fine organic matrix composition containing much small gravel. A yellow iron type deposit has accumulated on the underside of the bag. A subsample of approximately 100 cm^3. displaced volume was taken for analysis. After sieving an estimated 30% of the total sieved volume accumulated as a fine, black dust of under 150μm diameter in the basal tray and was discarded. Low power observation of the coarse fraction macrofossils was hindered by a residual grey opaque discoloration of the water on disturbance. Copious rinsing of all sieved fractions was necessary to remove this cloudiness, which is suspected to be clay or ash.

31cm^3 volume of substrate was collected on the 150μm sieve. Over 25cm^3 of this had an inorganic sandy content, to approximately 50%. Less than 6cm^3 was fine organic debris. 4cm^3 of the mixed substrate was analysed for seed content.

Matrix description:

bone to 5mm	spa
charcoal	occ
droppings (some charred)	ra
fine ash/clay dust (after sieving)	fq
gravel to 5mm	co-ab ~50% total
mosses	ra
plant epidermis fgmts	fq
Pteridium aquilinum pinnae (± sporangia)	ra
Pteridium aquilinum rachis fgmts	occ
sand	co
seeds (any)	occ
wood to 10mm	ra

This sample is much smaller than many others and so cannot be compared directly for species and numbers of individuals. The high percentage of black ash or fine clay dust which settled on the basal tray has not been encountered before. The large sand and gravel content in this sample may be from natural sources following abandonment or dumping. Alternatively this may signify clay, perhaps from a hearth or wattle situation. However, charcoal evidence is very slight in this sample and no carbonised seeds were found. Consequently it is not very likely that a hearth was in the immediate vicinity.

Plant macrofossils including *Linum usitatissimum* capsule valves and seeds, and *Triticum spelta* spikelet bases, provide scarce evidence for crop cultivation. Weeds of arable and grassy situations are noticeable as in previous samples. Bracken pinnae complete with sporangia implies late summer incorporation into the context.

4.6.5. Sample 94C6S2

This is a 1.5 litre sample in a circular container. C6S2 was taken in close proximity to the thin black layer of C6S1 near the centre of area C6, from a location where any water disturbance unsettled clouds of grey dust like clay or ash. Clouding of the water occurred even after the dissociated sieved components were observed at low-power, suggesting that small lumps of fine clay type material were becoming disaggregated in the water. As suggested for 94C6S1 this may be due to clay from wattle in-fill or a hearth where clay would have been smoothed over flat stones. The discovery of burnt bone, charcoal, and metalworking slag from area C6 during this and previous studies are highly suggestive indicators of a hearth somewhere nearby, but not in the immediate vicinity to samples taken for this study.

Large pieces of roundwood are mixed in with organic debris and micaceous sand, in two possible lenses. These were initially analysed independently, but this revealed no difference in the composition of the suggested bedding zones. Close examination showed they were only due to the random orientation of deposited bracken rachis. As a result there was no significant difference in the macro-fossil results for the two zones, and consequently they are tabulated together. Similarly the 150µm sieved fragments had no significant differences between them, and are described here together. 14.5cm^3 total substrate was settled, of which the organic constituent was dominant, to 80%. 5cm^3 was subsampled for seeds.

Large bark, roundwood and worked wood from major timbers were selected for identification separately, and did not form part of the volume subsampled for macro-fossil analysis.

Matrix description:

amorphous *cf* animal dung to 60 x 30mm	ra
bone fragments	ra
charcoal (to 3mm)	fq
fungal hyphae (branched)	occ
gravel to 5mm	occ
insect remains	ra
organic detritus (stem, leaf, vascular tissue)	fq
Pteridium aquilinum pinnae (sporangia occ)	co
Pteridium aquilinum rachis, to100mm (occ charred)	co
rachis	co
sand	co
seeds (any)	ra
Vivianite crystals	ra
wood (round)	spa
wood (worked chips)	fq

Macro-fossil evidence indicates seeds of grassland, heath, and woodland, along with cultivated cereals and gathered wild food species. Ovicaprid droppings are rare, but small, amorphous lumps of putative dung may be from another domestic animal. No cereal bran was observed in two of these aggregations, and human faeces are not suspected. The presence of fungal hyphae suggests the sample was exposed to the air for some days. The seed evidence is very similar to previous samples, and on-site processing and hay are indicated, along with general household activities.

There is a 4:1 ratio of *Juncus effusus/conglomeratus* to *J. bufonius.* Both species produce large numbers of seeds, but there is a noticeable height difference between the two, the former being 1-1.2m compared to 35-50cm (Stace 1991) such that if the rushes were being selected for thatching, lamp-making or flooring purposes, then the longer *J. effusus/conglomeratus* would be better. Also *Juncus effusus and J. conglomeratus* produce dense tufts, and consequently more seeds per location than *J. bufonius* with its open habit. However both types grow in the same habitat range, and could have been collected concurrently, whether coincidentally or not. *Juncus bufonius* could have been incorporated from the sandy clay mud in the sample.

Bracken rachis remains are long, mature and broken rather than cut, which suggests an even longer initial length. This in turn implies the collection or use of entire stems of the fern. Pinnae are observed to be generally broken down to pinnule level, but with some longer pieces remaining. This is indicative of bracken flooring or animal pen material. It is unlikely that rachis would be removed for human bedding. The equal quantities of pinnae and rachis do not suggest thatching material.

Two pieces of *Betula* sp bark to 35mm long were identified by their reflective surface and long, narrow lenticels. Both were moderately charred. Occasional smaller pieces of bark were observed, some of which were also charred at one end. The presence of burned bracken, roundwood and charcoal is highly indicative of the presence of a fire in reasonably close proximity. The scattering of the remains of a previous fire on the floor for whatever reason, perhaps to absorb moisture or to fill in a cavity, cannot be excluded, however. Fire ash has been used for such purposes since antiquity.

Wood is composed of angular chips and slivers up to 35mm in length, which have been formed manually down the longitudinal grain of the timber, and are indicative of deposited woodworking materials. The presence of several pieces of stripped bark implies the dressing of wood for whatever purpose. The wood is degraded in many cases, and no evidence is found of charring of the chips.

One crystalline structure 35mm × 15mm × 1mm was observed. This had the appearance of a loosely formed mat of mono and tri-clinic crystals which was approximately three crystals deep, with small spaces throughout. The structure was observed over a period of several days during which time the colour changed from being almost clear and translucent to an opaque, dark blue with a powdery grey-green surface. This occurred even though the crystal was kept in the dark in the chill cabinet as soon as any initial change was observed. Identification using x-ray diffraction was kindly arranged by Dr J. MacDonald of Glasgow University's Department of Geology. This concluded that the crystals were vivianite, an iron derivative of phosphorus. Vivianite is commonly found in archaeological deposits in blue powder form in open context acidic environments, including Anglo-Scandinavian York (Kenward & Hall 1995). It is likely to indicate the presence of bone and possibly iron salts too. The crystal form is far less common than the blue powder, which may imply an unusual set of events leading to its occurrence. The low, flat mat of crystals may suggest their formation at the interface of two discrete layers, possibly via leeching or some heat treatment. The organic detritus adherent to the spaces within the mat showed no sign of carbonisation, however, which would imply that no great heat was involved. Vivianite was noticed adhering to bone in areas C6 and A3 during the excavations (Dixon pers. comm.).

4.6.6. Sample 94C6S4

This is a 1.5 litre sample with long roundwood , worked wood, and gravel to 50mm. Ovicaprid droppings, *Pteridium aquilinum* rachis, twigs, small charcoal, and bark are contained within layers of compressed organic material with rachis mixed throughout.

Long eroded twigs to 230mm were present in the matrix. Some were compressed roundwood with flattened shiny bark, but the wood underneath this had rotted away. The twigs showed evidence of burning or charring. Bracken was very common, with rachis fragments frequently charred. Bark pieces were up to 70mm long, and many were also charred. A rusty brown deposit was observed in the water and on the wood edges, suggesting iron contamination, whether from an artefact, the surrounding matrix, or metal working slag.

500cm^3 was subsampled from this sample, which is larger than the volume normally used, but this was necessary to accommodate the very large pieces of wood within the sample. This method ensured sufficient organic matrix other than wood to approximate to the standard volume for seeds.

25cm^3 of detritus settled on the 125µm sieve. This was almost entirely composed of fine organic particles, including charcoal dust. 5cm^3 was subsampled and revealed no identifiable macrofossils.

Matrix description:

bark (to 70mm, many charred)	fq
charcoal	fq
droppings	occ
gravel (to 50mm)	spa
moss	occ
organic detritus	fq
Poaceae (large) processing waste	spa
Pteridium aquilinum pinnae	occ
Pteridium aquilinum rachis	ab
roots	spa
seeds (any)	spa
straw	occ
wood (generally)	co
wood (round)	occ
wood (worked)	occ

This sample is very rich in plant remains, although care is necessary when making deductions from this as the sample size is larger than normal. Seeds are prolific, and macrofossils including wood, bark, charcoal and bracken rachis are generally of large size. Long, mature bracken rachis is mixed with large pieces of bark (some charred), and charcoal to 20mm. Wood appears to be manufacturing waste, with cut twigs, bark (removed with an axe and retaining wood slivers), and worked wood fragments. The general condition of these is poor, however, and specific identification is unlikely.

Moss fragments are not abundant, but the majority are *Neckera complanata.* This species recurs time and again in samples and must have been selectively gathered for various purposes.

Charred twigs and bark (± wood adherent) and rachis fragments have seeds and detritus embedded in them and compacted on to them. Ovicaprid droppings are interspersed through the matrix, and have straw fragments and seeds compacted on to them. An orange-brown precipitation on the wood and bark may be from iron work in the vicinity.

Many of the seeds are from arable/pastoral and wasteland habitats, and a lot of cereal processing waste was noticed, especially spikelet bases of wheat. As in previous samples, many seeds of a diverse range of cereal crop weeds were present in the assemblage, especially *Bromus hordeaceus,* *Cerastium fontanum/glomeratum, Chenopodium album* and *Galeopsis* subg *Galeopsis.* Again, the fairly numerous *Hordeum vulgaris* bran are not concurrent with scarce barley chaff, and the converse is true for *Triticum* species. This is thought to be due to the wheat waste going to fodder, whilst the valuable grain is retained for human consumption. Barley chaff may have eroded naturally. Some of the less precious barley grain may have supplemented the fodder, or tail grain may have been added.

Hay from damp and wetter pasture is indicated by the range and abundance of *Carex* and *Ranunculus* species, the latter of which are especially numerous. The frequent occurrence of species including members of the Poaceae and petals of *Trifolium repens* are highly suggestive of hay. The numerous seeds of *Urtica dioica* and *Prunella vulgaris* present could be from hay assemblages but suggest selective gathering of the species, possibly for fibre or medicinal purposes respectively.

The abundance of long, thick bracken rachis but few pinnae suggest uses other than flooring/bedding material. It is suggested that this may have been intended for thatch. There is no evidence of *Juncus* spp in this sample to suggest rush flooring. Sheep or goat droppings suggest animal husbandry at this location, with general household activities suggested, including house repairs or artefact manufacture and crop processing. As in previous samples there are insufficient droppings to confidently say an area was used as an animal pen. Animals may have been inside for short milking stays, or the pen could have been frequently cleaned out. Further excavations may provide more concrete evidence of long term animal husbandry.

4.6.7. Sample 94C6S9

This sample consists of a 2 litre container approximately ½ full of organic material, filled to top with water. Long bracken rachis is emergent from the matrix. A 30mm layer of this long rachis and a few twigs with little adherent debris overlies a 40mm thick layer of rachis with much adherent organic debris including rounded lumps (various sizes) of soft, brown fine textured material with the general appearance of faeces, and the occasional gravel and wood chips. Small *cf* dung concretions had the appearance of goat/sheep droppings, and 3 were analysed separately for parasite eggs. A further independent analysis was undertaken for pollen on one goat type dropping, the results of which are given in chapter 7.

200cm^3 displaced volume of substrate was analysed. 94cm^3 of detritus settled on the 150µm sieve, of which 32cm^3 was searched thoroughly for macrofossils. The rest was briefly scanned but contained nothing new.

Matrix description:

bone	ra
gravel	ra
insects	ra
moss	spa
Pteridium aquilinum pinnae	occ
Pteridium aquilinum rachis	ab
seeds (any)	fq
twigs	ra
small vegetative detritus	co
worked wood	occ

Bracken rachis in the sample is long, thick, and mature, with blackened base. It has the appearance of having been collected late in the summer or early autumn and is frequently broken into shorter fragments as if damaged. Pinnae are not abundant by comparison, and sporangia are not present. Use of the bracken for roofing or related purposes rather than flooring or bedding is suggested. Moss fragments are not abundant and only large weft-forming species are indicated.

The cereal processing assemblages seen in many other samples are present here too, with large numbers of *Hordeum vulgare* bran fragments and chaff of barley, *Triticum dicoccum* and *T. spelta.* The crop field weed assemblage is as prolific and varied as before. *Trifolium repens* petals and small Poaceae indicative of hay assemblages are present, although other grassland indicator species are less abundant than in previous samples. New additions to the assemblage include *Sisymbrium officinale* and *Torilis japonica.* Crop waste combined with fodder cut from field margins and tracks could account for the abundance of small grasses and arable/waste species in this sample. As noted in previous samples, the occurrence of low growing species such as *Aphanes inexpectata* denoted the crop and/or hay was cut close to the ground.

Evidence for gathered wild food comes from the *Corylus* nut shells and seeds from the fruits of *Empetrum nigrum, Rosa cf canina, Rubus fruticosus s.l.* and *R. idaeus.* One *Papaver somniferum* seed may be from cultivation or accidental incorporation. *Calluna vulgaris* remains are more frequent than in other samples, and reflect gathering from areas of heath on the slopes of nearby hills.

Three ovicaprid droppings were quickly analysed for parasite eggs following the method described by Dainton (1992). The droppings contained many fragments of grasses, torn moss leaves including *Sphagnum* spp, fern scales, and unidentifiable plant epidermis. A piece of *Avena* sp pericarp was probably from the wild *A. fatua.* Fern sori were common, and were frequently broken. This does not concur with the rest of the matrix, where sporangia were absent, and suggests either that the animals ate ferns elsewhere, that sporangia came in with drinking water, or that they had been previously wind blown onto the food the animals were browsing on. Bracken pinnae in the matrix surrounding the droppings were few compared to rachis, which was thought to reflect selective use of the stems of this fern. This may have been for a purpose other than bedding, and suggests mixed contexts in the sample. The lack of bracken sporangia in the matrix implies that pinnae were not absent due to their consumption by animals.

Fungal spores of various types were common in the droppings. Many hairs were also noticed, both of animal and plant origin. Pollen was counted separately from faeces prepared by conventional means, but types noticed on smear slides of these droppings included small Poaceae and *Alnus, Calluna vulgaris, Plantago lanceolata* and *Ranunculus* species.

Only one *Tricuris* sp (tapeworm) egg was seen, although 16 slides were scanned. The conclusion was that either the technique is poor, or few eggs were present. A decision was taken to do a proper pollen preparation of a further one ovicaprid dropping, in this case recognisably from a goat, to see if any eggs showed up in this manner. This process had the added incentive of supplying accurate information for a pilot study into the feeding habits of the animals husbanded on the crannog. The results for this pollen analysis are given separately in chapter 7

The samples from area C6 appear to show the same mixture of cereal crop and fodder assemblages as those of previous squares, but ovicaprid droppings are generally more numerous in C6 than the main mound, which may reflect a preference for husbandry on this extension at one point. There does not seem to be the suggestion of specificity of use that was observed from the various areas within the larger mound. It is tempting to think that the occupants might have lived here with their animals while the larger dwelling was being constructed, but of course this is supposition.

Sandy clay is incorporated into the matrix in several of the samples, and mire indicator species including some from standing water such as *Carex rostrata* and *Glyceria fluitans* suggest this was added intentionally. Clay may be from a hearth or other unknown purpose. Ash in the samples suggests a fire in the vicinity.

Papaver somniferum seeds were only found in C6 contexts, but this is thought to reflect the abundance of samples analysed from this area rather than their absence in other locations.

4.7. Area D2

One sample was studied from D2. This square is at the south-eastern perimeter of the excavation site, and has not been extensively studied. It is on a steep slope, with the organic component going beneath the silt of the loch bed. It terminates in area E2, where recently a further ring of pile points has been discovered buried under the loch bed silt (Sands 1994). This suggests the site may have been larger than was expected and emphasises the protective role of the boulder capping on the main mound and extension. One sample was taken from D2 to give an overall view of the site in general.

4.7.1. Sample 94D2S7

Sample 94D2S7 90% fills a 2 litre container. The sample is almost entirely composed of roundwood branches of various ages, from first year twigs to ones with 7-8 growth rings visible. Many of the rods are snapped cleanly across with the weight of organic material overlying them. Lengths vary, from small 40mm long narrow twigs, to 180mm long 8 year old rods.

The largest roundwood fragments are at the top of the sample, with smaller ones underneath as if they have settled due to degradation of matrix around the wood. The top layer, 35mm thick, is almost entirely composed of medium to large diameter rods, some with one end axe marked, and very little adherent organic matter, almost all of which is detritus from the wood, including bark and wood fragments. This was examined separately and produced no seeds or other macro-fossil evidence.

Below this the organic matrix contained many small and occasional larger twig, and many small worked wood chips. The bottom 10mm of the matrix consisted of sand and loch bed silt with small twigs and organic detritus.

Large wood was analysed separately. 200cm^3 volume of matrix other than this was analysed for plant macrofossils. 80cm^3 volume was retained on the 150μm sieve, of which almost 60cm^3 was fine mica sand containing no organic remains. 20cm^3 sandy organic matrix settled in the measuring column above the sand. 7cm^3 was subsampled, which yielded many more insect remains than seeds. Scanning of the rest of the 150μm subsample revealed these levels were consistent throughout the rest of the fraction.

Matrix description:

bone to 3mm	ra
charcoal	ra
insects	occ
leaf debris	ra
moss	ra
Pteridium aquilinum pinnae	abs
Pteridium aquilinum rachis	ra
seeds (any)	ra
wood (round)	dom
wood (worked chips)	co

This sample was taken from the steep side of the organic mound in D2. The site maps show three rows of piles at the D2:E2 interface, but then none up to C2. The extreme slope of this square has led to the supposition that the subsidence of this area may have been catastrophic (Dixon pers. comm.). Large broken stones in the organic matrix shown in site plans may be remnants of a collapsed hearth which could have slipped from a more central position. This is a very disturbed area.

The majority of plant remains were woody, in the form of roundwood, wood chips, charcoal, leaves, buds and tree species seeds. Rare small moss fragments and woodland species including possibly *Carex sylvatica* are likely to have come in with the wood. Other species in the matrix can grow in woodland clearances, but are also characteristic of waste and arable places too. The rare presence of wheat processing waste emphasises the mixed nature of this assemblage. This is generally the case for the whole site.

Insect remains are far more numerous here than in than previous samples. A few of these are water borne and could have come from either the loch itself or through the incorporation of wet clay, possibly for a hearth. Others, but not all, could have been incorporated with the wood.

94D2S7 differs from other samples in that bracken remains are very scarce, there is little evidence of hay for fodder or flooring, and *Juncus* spp seeds are not particularly abundant. This suggests that the context represented is not from within the dwelling itself, but from either the perimeter walkway or dumped waste. The numerous insect remains include those of flies, beetles and occasional water insects, and are consistent with discarded material lying above water level for long enough for eggs to be laid and larvae to pupate. In good weather it is likely that piecemeal crop processing would occur out of the dwelling, in daylight. It is suggested that household waste including wood working materials, cereal crop weed assemblages and occasional gathered fruits were discarded on the walkway where they became infested with insects. One *Prunus spinosa* fruitstone has been gnawed by a small rodent. The remains may have been eventually discarded into the loch.

4.8. Area E2

E2 is directly behind D2, at the perimeter of the boulder covered mound. One sample was taken for this study, from an organic layer overlying tips of piles at the southernmost extremity of the excavation. This layer built up after the piles it covered had eroded down to loch bed level. Sands (1994) considers those piles to be part of the original free-standing pile structure.

4.8.1. Sample 90E2S5 016

The sample $^3/_4$ fills a 2 litre box. Previous boxes were filled to the top with water, but in this case there was no standing water above the sample, which had an estimated organic component of less than 50% and a gritty, dry texture like wet sand.

200cm^3 displaced volume was subsampled for analysis. A total of 64 cm^3 displaced volume of organic material was collected on the 150µm sieve. 7cm^3 of this was examined for plant macrofossils.

Matrix description:

calcined bone to 25mm (mainly<2mm)	occ
charcoal to 10mm	fq
charcoal to 40mm	occ
gravel <5mm	co
gravel >25mm	ra
gravel 5–25mm	fq
insects	ra
iron slag drips	spa
mosses	ra
Pteridium aquilinum pinnae	ra
Pteridium aquilinum split mature rachis	occ
seeds (any)	spa
stem tissue	spa
wood (round, some charred) to 140mm	spa
wood (worked)	occ

The abundant gravel in the sample is of the local mica schist and quartz, and must have been intentionally collected. The natural loch bed silts have a much finer consistency than this, and are not suspected. Gravel may be from the boulder capping or been used by the crannog occupants. Wood from household activity was not frequent, but much more charcoal was found than in any previous samples. A total 7.6g was obtained, in fragments up to 40mm long, although as mentioned previously this is still a very modest amount compared to other sites. Other burned material included bone, iron smelting slag drips and bracken rachis, but no carbonised seeds were found and parching of cereals is not indicated. This combination of elements are highly suggestive of waste from a fire, and the metalworking waste suggests smelting with charcoal. However, temperatures of 1540^{0}C are required to smelt iron (Tylecote 1962) so this is perhaps unlikely to have been on the dwelling for reasons of safety. Scattered fire waste could be used for various purposes within the household though, for example to absorb moisture or level an area, and insufficient evidence exists to be more specific as to its origin. Smelting is discussed more fully in chapter 6. The abundant sandy gravel in this sample may represent a stony hearth or have been dumped with fire waste to level the area.

This sample contains small numbers of several *Carex* species, all of which indicate wet habitats. In particular *C. rostrata* probably grew in the loch margins and may have been collected with the sandy gravel. Two caddis fly larvae cases may have had a similar provenance. The macrofossils other than the carbonised assemblage show low levels of the same cultivation waste and flooring material seen in previous samples, and represent a general household floor. The only moss present was *Hylocomium splendens*, found in moderate amounts, and not suggestive of any particular use.

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C 6S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Agrimonia eupatoria										1								
Agrostis sp		10	1	2	5	1	3		4	25		6	19	11	4	50		
cf *Agrostis* sp	2															3		
Ajuga reptans			1			1												
Alnus glutinosa			2	1	11	25	2		1	28			5		3		2	1
Alnus glutinosa catkin & cone fgmt.						30	6											
Alnus glutinosa flower										1								
Alnus sp charcoal			1	1					3		1	3	2	1			2	1
Alnus sp wood			10	3					1	4		2		2		2	2	
Alnus/Betula sp wood										39						1		
Anagallis cf arvensis		1																
anther indet.					1													
Aphanes arvensis			1															
Aphanes inexpectata										2			3			3		
Arctium lappa/minus														2				
Asteraceae					1													
Avena sp				1						6	1							
bark (small fgmt.)												~		~				
Betula cf inner bark														3				
Betula pendula			2														1	
Betula pubescens									3	1					3		1	
Betula cf pubescens					1													
Betula pendula/pubescens			1															
Betula sp		1				2				3						1	1	
Betula sp bark									3	1		~						
Betula sp charcoal fgmt.					3					4	1	2	1			1		1
cf Betula sp catkin scale																		1

Table 4.1. Plant taxa and miscellaneous finds in samples. Plant remains are seeds unless otherwise designated. The symbol '~' is used in cases where frequent remains were uncounted (continues overleaf)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Betula sp wood fgmt.			10		2				3	43		1				1	7	
Brassica rapa ssp *campestris*			6	1	1	1			1	2		1			12			
Brassica cf rapa ssp *campestris*						1												
Bromus hordeaceus		2	28	6	3			3	1	30		4	59	1	2	12		
Bromus sp		1	36	6			2	1	2	5		1	9	2		13	1	
buds indet.		2		~	~	2				~	3	15		11	3	5	9	
Callitriche stagnalis																	1	
Calluna vulgaris				1								1				59		
Calluna vulgaris branch tip																1		
Calluna vulgaris capsule valves														5		87		
Calluna vulgaris capsules			1							3		3		1	10	23		
Calluna vulgaris flower			1												4			
Calluna vulgaris leaves														4				
Calluna vulgaris petals												2						
Campanula rotundifolia						1												
Campanula sp													1		1			
Cardamine cf flexuosa					1													
Carex disticha		4		1				1			2	4	12				1	2
Carex cf disticha		1						1						1				
Carex disticha/ovalis												1	13					
Carex cf disticha/ovalis										1						8	1	
Carex echinata		1	1			4			1			2		2	1			1
Carex cf echinata						1									2			1
Carex echinata		1	1			4			1			2		2	1			1
Carex flacca																		1
Carex hostiana		5		2			1		1	2		2	2	2	5			1
Carex cf hostiana										1		1	4		1			
Carex nigra		1					1		2			1	1					1

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Carex cf nigra			2															
Carex ovalis		2	7	1					1	21				1				
Carex cf ovalis		1	1							1								
Carex panicea						1			2	1					2			
Carex cf panicea			1			1			2				1					
Carex pilulifera			1															
Carex cf pilulifera									2									
Carex rostrata			1								1							
Carex cf rostrata												1						
Carex cf strigosa/acutiflora utricle					1													
Carex sylvatica		1								1	2				1		1	
Carex viridula cf ssp *oedocarpa*		2	2			11	2		5	1			4		13			2
Carex viridula s.l.																9		
Carex sp	1		3	1	4		1		3			1	2					
Centaurea cf nigra						1												
Cerastium cf fontanum				1		1												
Cerastium fontanum		20	24	7						177	1	2		4	4	32		1
Cerastium fontanum/glomeratum													210					
Cerastium glomeratum								3										
Cerastium sp		2							3	1		1						
charcoal indet.			~		~	1	~	~				~	~			~	5	~
Chenopodium album		3	165	25	18	2		1	4	58	6	13	17	5	5	32	23	2
Corylus avellana	113		7	1	9				4	46		5		4	3	3	9	1
Corylus avellana catkin				1														
Corylus sp charcoal fgmt.	1	1	1	1	2					4	1	2	3	2				1
cf Corylus sp charcoal fgmt.																		
Corylus sp wood				23	9				3	1		4					39	
Danthonia decumbens		2			2					6			6	3	1	1		
Deschampsia cespitosa		1	1	11	2		1		1		1	2	2	2	6	4		
Deschampsia cf cespitosa															4	3	1	

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Dryopteris cf filix-mas leaf scale			1															
embryos indet.														3				
Empetrum nigrum									1							1		
epidermis fragments														~				
Epilobium montanum		1																
Erica tetralix							1		1									
Fallopia convolvulus		2	18	3				2		14			1	1	9	1		
Filipendula ulmaria			7		2	1	1				1		11				1	
flower indet.							1							1				
Fragaria vesca			3	1														
Galeopsis subg *Galeopsis*	1	4	67	8	17		3	7	2	27	3	2	24	2	25	6	2	2
Galium aparine		1		2												4		1
cf *Galium* sp										4						2		
galls		2													1			
Glyceria fluitans			1	1	2										1	1		
Glyceria cf fluitans					1													
cf *Gnaphalium* sp												1						
Heracleum sphondylium			8							1	2		4					
Holcus lanatus					2		3			3		3	4		7	20		
Holcus sp		1										1	1		2	5		
Hordeum vulgare s.l.		36	191	34	9		31	11	1	49	14	48	54	36	65	119		2
Hordeum vulgaris (carbonised)										1								
Hordeum sp rachis internodes			8				2			5	2			5		14		1
cf *Hordeum* sp		1	3	5			1	3		1	2	1	1	2	1	1		
Hordeum sp cf rachis internodes													2			10		
Hypochoeris radicata										1								
Isoetes cf lacustris megaspore																	1	
Juncus bufonius		(31)		(12)	(121)	44	7		(3)	(351)	426	28		(11)	(3)	(10)		(18)
Juncus bufonius capsules					3													
Juncus cf bufonius												1						

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Juncus articulatus/acutiflorus		(109)			(16)	246	36		(11)	(46)	39	3		(38)		(60)		(9)
Juncus effusus/conglomeratus	14	(891)		(74)	(694)	15	32	80	(334)	(1999)	240	158		(253)	(125)	(178)	(90)	(485)
Juncus effusus/conglomeratus capsules			1		3						9	1			2			
Juncus cf effusus/conglomeratus												1						
Juncus squarrosus		1																
Lapsana communis		3	58	20	4		11	3	7	7	8	7	6	5	28	32	2	3
leaf detritus								~									~	
leaf scar												1						
leafy fgmt. *Cf* sepals																2		
leaves *cf Corylus/Alnus*								3										
Leontodon autumnalis/hispidus						2				1			1					
Leontodon cf autumnalis			1															
Linum catharticum				2	2	2			1	3			9	1	2	1		
Linum catharticum capsule fgmt.													1					
Linum usitatissimum			68		1			1	2		3		1					
Linum usitatissimum capsule fgmt.			93								8							
Luzula sp		1	3							9			13		2			
Luzula sylvatica																1		
Lycopus europaeus																1		
Montia fontana					10												2	
Montia fontana ssp *variabilis* fgmt.									8		8							
Myosotis arvensis/sylvatica					1					1					1			
Papaver somniferum															2	1		
Papaver sp										1					1			
Persicaria lapathifolia			43	1	4			3		25		1	8	5	9	10	4	3
Persicaria maculosa			12	1	2			1		4		1	2	1	3	1	3	
Persicaria cf maculosa			35		3													
Persicaria cf lapathifolia/maculosa														3				
Persicaria sp flower															1			
petals				3											2			

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Plantago lanceolata			1	1	1					2			2		2	1		
Plantago cf lanceolata		1								1								
Plantago major		3	13	1	2					1					18	3		
Plantago sp capsule fgmt.										1								
Poa annua					8		1	3		1			1		4	1		
Poa humilis			1				2				2		1	2				
Poa pratensis		2	2	3	3		1	1		17		3	23	1	2	14		
Poa cf pratensis						1			5	3			3		2	2		
Poa trivialis		1	2						1	5	1	4		3		5		
Poa cf trivialis												1	5		2			
Poa sp		11			2	3		1	1	2		3	5	1	1	4		
cf Poa sp	1		1														1	
Poaceae (large)		1	20					2		9		3	10	3		10		
Poaceae (large) rachis internode							2				1				5			
Poaceae (small)	2	1	2	2	2	1	1		1	7	2	5	8	1	8	13		
Poaceae sp (large) culm fgmt.			12				4				2		13		3	8		
Polygonum arenastrum											3					1		
Polygonum aviculare					6													
Pomoideae wood *cf Sorbus* sp							1											
Potentilla erecta						9				6	3	1	4	1	3	1	1	3
Potentilla sp																		1
Primula vulgaris																6		
Prunella cf vulgaris								1										1
Prunella vulgaris		43	9	3	1	1			6	118	2	3	182	11	38	19	1	
cf Prunella sp						1												
Prunus padus	2									4								
Prunus sp										2								
Prunus spinosa	37		3		1		1			24		1	1				1	
Prunus cf spinosa	3																	
Prunus spinosa type twig								1										

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Pteridium aquilinum		~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Quercus sp charcoal fgmt.			1		2					4		1						
Quercus sp wood					5				2			1		6				
cf Quercus sp charcoal fgmt.										1								
cf Quercus sp wood																1		
Ranunculus acris/bulbosus		3	8	1	2	2	1		2	33		1	57					
Ranunculus cf acris/bulbosus		1									1							
Ranunculus flammula		2	5		1	3			5	1		1	1		2	2		1
Ranunculus repens		2	21	5	12				2	62	9	1	63	4	4	3	4	
Ranunculus cf repens		1					1						27	4				1
Ranunculus section *Ranunculus*		4	6	6	4	1			1	30	2	1	52		9	4		
Rhinanthus minor			1				1											
Rhinanthus sp									1				3		1			
Rosa cf canina			6											1		6		
Rosa sp					1					12								
Rosaceae cf thorn										4								
Rosaceae thorn		1											1					
Rubus chamaemorus			5							2								
Rubus fruticosus s.l.			3		1				1	2						3		
Rubus idaeus		1	10	3	3				4		1				13	2	5	
Rubus *cf* idaeus										7		1					4	
Rubus idaeus/fruticosus			3	2					2		1		4			1		
Rubus cf idaeus/fruticosus									4									
Rubus sp fgmt.										14					1			
Rumex acetosa + tepals			1															
Rumex cf acetosa																1		
Rumex acetosella										65		2	52		1	6		
Rumex crispus										1								
Rumex crispus fruiting tepal			1															
Rumex crispus perianth															1	1		

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Rumex obtusifolius											3							
Rumex obtusifolius/crispus				1														
Rumex sanguineus		1								1								
Rumex sp						1				1	1	1		2	1			
Sagina apetala					1													
Sagina procumbens						39	1				1							
Sagina cf procumbens							1											
Sagina cf subulata			55			40												
Sagina sp					1		2				2							
Salix sp wood									2								1	
Selaginella selaginoides leaf															1			
Selaginella selaginoides megaspore						4	1		1									
Silene dioica			3				1							2	2	2		
Silene cf dioica																4		
Sisymbrium officinale		1			2									3		2		
Sonchus asper		1	21	5	5		1	2	2	3	2	11	3		10	2	2	
Sonchus asper cf													1					
Sorbus aucuparia			3															
Sorbus sp charcoal fgmt.												1		1				
Spergula arvensis				2						2			4		2	3		
Stachys cf palustris															1			
Stachys sylvatica			3			1				1								
Stellaria graminea		3	2			4			2	6	1	2	3	3	3	2		1
Stellaria cf graminea								1										
Stellaria media		14	29	4		1	1			10	8		5	1	1	4		1
Stellaria cf media										1								
Stellaria sp											1							
stem indet.											~							
stem tissue (monocot)					2													~
tendril										1								

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Torilis japonica																1		
cf Torilis japonica			4															
Trifolium cf *repens* flower							1											
Trifolium repens petal			3		3								12			7		
cf Trifolium sp petal										1								
Triticum dicoccum glume base			23						3	9			39		4	7		1
Triticum dicoccum spikelet base			7						3	8			14		1	1		
Triticum cf dicoccum glume base									2			1			9			
Triticum cf dicoccum spikelet base		1							4	1					1			
Triticum spelta			6															
Triticum spelta glume base			53		4				1	17			19		3	2		
Triticum spelta spikelet base			11				2		1		2		9			1		1
Triticum cf spelta					2													
Triticum cf spelta glume base					2				2								1	
Triticum cf spelta spikelet base									1									
Triticum spelta/dicoccum sp			1														1	
Triticum spelta/dicoccum glume base					1				20	22						6		
Triticum spelta/dicoccum spikelet base			9						2									2
Triticum sp			20	3	1		1			1			2					
Triticum sp glume base			53		1					54		3	62					
Triticum sp spikelet base													21					
Triticum/Secale sp	1		54	8	5		2	1	2	7	1	1	12			8		
Ulmus sp charcoal fgmt.										3	1							
cf Ulmus sp charcoal fgmt.										1								
Urtica dioica	5	23	42	25	5	17	4	1	29	237		3	447	18	35	38	1	4
Vaccinium myrtillus-vitis idaea		1	6	1						11								
Vaccinium cf myrtillus/vitis-idaea										1								
Valeriana officinalis			1															
Veronica beccabunga																2		
Veronica chamaedrys													1		7	12		

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
Veronica sp										1								
Viola cf subg *Melanium* fgmt.													6					
Viola cf subg *Viola* fgmt.			10												2			
Viola palustris																	1	
Viola sp		2				1	1			15		1						1
Viola sp pod fgmt.										6		1						
Viola subg Melanium													10	1	1			
Viola subg *Viola*					1	1									1			
Violaceae pod fgmt.													1			1		
wood fgmt. indet.			~		~	~	~	~	~		~		~		~	~		~
Mosses. In these cases only, abundance is registered by: '+' = present, '++' = frequent, '+++' = abundant.																		
Antitrichia curtipendula												+						
Calliergon cuspidatum											++							
Eurynchium cf striatum			++															
Eurynchium sp		++		+		++												
Hylocomium splendens		++	+++	++				++	++	+					++			++
Hypnum cupressiforme		++		++				++						+			+	
Neckera complanata		+++	+++	++			++		++	+		+++	+++	+	++	++		
Pleurozium schreberi								++										
Rhytidiadelphus squarrosus			+++															
Sphagnum palustre				+														
Sphagnum spp		+		+			+		+					+			+	
Thuidium tamariscinum		++	++	+				++								++		
Unidentified small moss spp		+	+	+	+	++	+	+	+	+		+			+	+	+	
Miscellaneous environmental finds																		
Bryozoan statoblasts indet.			3															
Cristatella sp (Bryozoa)							1											
Plumatella furgosa (Bryozoa)																	4	
cf animal skin fgmt.												1						

Table 4.1. (continued)

Sample/ Species name and part	90A 1/2	90A 2S3	94A 2S5	81A 3S4	94B 4S8	91C 1S5	91C 1S6	91C 1S8	91C 2S7	87C6 S1	94C 6S1	94C 6S2	94C 6S4	87C6 S5	87C 6S6	94C 6S9	94D 2S7	90E 2S5
bone					2				11	5		8			3		3	~
caddis fly larvae cases			1		2					1	2	1					6	2
Coenococcum geophyllum (fungal)			2			3	5											
Daphnia sp ephippia			1														2	
fungal sclerotia indet.											1							
insects (eggs, fly pupae, beetle parts)	3	~	~	~	~	51		3	~	~	~	14	~	1	~	12	176	~
iron smelting slag drips																		~
ovicaprid droppings					5				10	~		2		5	~			

Table 4.1. (continued)

CHAPTER 5: INDICATIONS OF THE LOCAL AND REGIONAL ENVIRONMENT AT THE TIME OF OAKBANK CRANNOG

The fertile soils in the Lawers area of Breadalbane are based on schist and limestone, making them particularly suitable for cultivation on the flatter areas. Higher up the hills, the interdependence of the climate and altitude with this micaceous soil is responsible for the floristic diversity and number of rare species for which the Ben Lawers area has been made a National Nature Reserve by the Nature Conservancy Council. Ben Lawers itself is now in the care of the National Trust for Scotland, and is visited by thousands of botanists, walkers and natural historians every year.

In late pre-history the woodland immediately around Loch Tay was based primarily on oak to about 900 feet, with birch and pine on the higher ground (McVean & Ratcliffe 1962). Clearance of the woodland around Oakbank Crannog for agriculture and construction resulted in open areas which would have been colonised by herb and scrub communities. Cultivation and grazing by domestic animals and deer would have kept these areas free of woodland regeneration (McVean & Ratcliffe 1962), and micro-topographic irregularities in the resultant field layers would allow colonisation by species favouring damp or drier ground. As the habitation site was a stilted free-standing dwelling in the loch, the lake-side vegetation would have played an integral part in the land utilisation by the community there. Alder carr fringing the loch must have formed the basis for the prolific evidence of the utilisation of *Alnus* wood on the site. Mixed deciduous woodland communities and also heath from the slopes of the surrounding hills are suggested from the plant macro-fossils found.

Tables 5.1. and 5.2. give an indication of the range of habitats represented by the species list from Oakbank crannog. Any taxon may fit into one or several of these arbitrary habitats, which ultimately form a continuum. This is seen most prominently in the case of the heath/mire category, which covers the spectrum from dry calcareous and damp heath to the range of peat-forming mires, from ombrogenous bog to fen and lake-shore communities and ultimately to submerged vegetation. As a result decisions have had to be made regarding the cut-off point for each category, causing a degree of overlap with respect to individual species. Furthermore some plants have such an ecological amplitude that they cannot be taken to indicate any one in particular, even in terms of the broad classifications devised here. *Pteridium aquilinum* and *Lapsana communis* are notable in this respect. The spectrum covered by each category is discussed in the text.

Community classification, descriptions and distinctions for each taxon are based on field knowledge but primarily on literature including White (1898), McVean & Ratcliffe (1962), Burnett (1964), Clapham *et al.* (1987) and Rodwell (1991). Information regarding the abundance of individual species in the Perthshire area is taken from the above, but also Perring & Walters (1976), Smith *et al.* (1992) and Hill *et al.* (1992 & 1994). No attempt can be made to quantify the proportional sizes or specific nature of areas covered by each community type as these are aggregations of human-influenced plant remains rather than a natural assemblage. They may also be subject to differential preservation, with sensitive, delicate or processed species being under-represented.

5.1. Wood/Scrub Communities

This category ranges from alder carr to drier mixed deciduous woodland including closed canopy, open and wood margin species and scrub communities. Oakbank results suggest that wet *Alnus* woodland was predominant near the shores of the loch, with carr including also *Salix, Betula* and *Juncus* species, *Filipendula ulmaria, Montia fontana, Ranunculus repens* and waterside/submerged species in the very wettest areas. The floristic variation with relation to the soil water and base content in alder woodland is shown in McVean & Ratcliffe (1962, table B, p24). This suggests areas of high and low water content and all levels of base richness around Oakbank.

The water content of the soil would in part be determined by the topography around Oakbank Crannog. The areas fringing the loch would be wet, with mixed alder carr, but this would have led onto a more general damp but better drained mixed *Quercus* and *Betula* woodland on the flatter areas. This is the sort of land suitable for clearance for agriculture. However, the loch side frequently slopes fairly steeply from the margins leading to much drier and better drained ground, supporting mixed oak woodland with birch, and some alder, although less than at the lower levels. *Ulmus* was also occasionally present, as was *Fraxinus* (Sands 1994). *Corylus* would have been frequent in clearings and margins here, or forming mixed tall scrub with *Rosa, Prunus* and *Sorbus* species with a *Pteridium aquilinum* understorey.

Damp open wood herb communities are suggested from Oakbank results, including *Agrostis* species, *Deschampsia cespitosa, Carex sylvatica, Filipendula ulmaria, Holcus lanatus, Luzula sylvatica, Rubus idaeus,* and *Potentilla erecta,* which would have been common on the woodland floor. *Vaccinium myrtillus/vitis-idaea* seeds were occasional at Oakbank. Bilberry/cowberry can form a dominant part of Highland birch wood floor (Burnett 1964), and may have been a constituent in the woodland suggested here, but macrofossils were not extensive in the crannog remains. The species are potential food plants, but as human faeces are not known from the site, this may be why they are uncommon. However *Rubus* species were present more frequently in the matrix, which may indicate that *Vaccinium* was just not so abundant in the immediate vicinity for plentiful collection. This is possible in that the woodland in the proximity to the crannog was thought to be oak dominated. *Vaccinium* species may have been more prolific further up the hillside, where oak woodland gave way to birch. McVean & Ratcliffe (1962, table A, p22) list species frequently found within a mixed deciduous woodland community, which concurs with many of the species identified at Oakbank.

Macrofossil evidence suggests that the herb-rich stands may have included such species as *Cardamine cf flexuosa, Carex flacca, Dryopteris filix-mas, Epilobium montanum, Fragaria vesca, Lapsana communis, Myosotis arvensis/sylvatica, Primula vulgaris, Prunella vulgaris, R. fruticosus s.l., Rumex acetosa, R. sanguineus, Silene dioica, Stachys sylvatica, Stellaria graminea, Teucrium scorodonia, Urtica dioica, Veronica chamaedrys* and *Viola* species as well as those mentioned above. There are no species exclusive to this mixed deciduous association, however, and some mentioned above are not exclusively woodland plants but will grow in waste and grassy places as well. Nevertheless the macro-fossil assemblage is extensive enough to indicate these general woodland categories whilst highlighting the complicated issue of designating habitat classifications.

Due to their dependence on a film of water to complete their life cycle, mosses are found in damp, shady places, and all the species identified from Oakbank can grow in various types of woodland or scrub. Growth habit and size of moss species determines their preferred localities within this broad grouping, with the weft-forming and smaller forms of acrocarpous species growing on rocks, tree trunks and fallen boughs, whereas the larger ecotype acrocarpous mosses are more characteristic of the woodland floor or clefts in rocks. Only moss species with a growth habit and morphology useful to man were identified from Oakbank in this study, due to constraints on time and the aims of the project. The most commonly occurring moss from Oakbank, found in eleven out of eighteen samples examined here was *Neckera complanata*, a species which favours base-rich rocks and tree trunks in woods and scrub. It has had anthropogenic associations since antiquity (see Dickson 1973), and indeed the presence of this moss on the Tyrolean Iceman's clothing was responsible in part for determining his provenance (Dickson *et al.* 1996). It is likely that the inhabitants were selectively gathering *Neckera complanata* for household use. Discussion in this respect will follow in the section dealing with potential uses of wild plant species.

It is interesting that so much *Neckera complanata* is found compared to most other species which would be equally useful. It may be that the fact that the moss grows in almost pure stands which can be ripped easily from a fallen bough is responsible for its dominance of the moss flora. The only other moss which is almost as abundant at Oakbank Crannog is *Hylocomium splendens,* a species which favours the wetter environments including woodland carr and mire and damp grassland. This species frequently grows in association with *Pleurozium schreberi* although there was only evidence of the latter moss in one sample. It is likely that the intentionally gathered species was *Hylocomium splendens* and the *Pleurozium schreberi* was an accidental incorporation. This shows some selectivity of selection, but also demonstrates the potential range of environments from which moss species could be gathered.

Sphagnum palustre leaves were found in sample 81A3S4, and *Sphagnum* sp. leaves from five other samples may be the same species. This woodland moss favours eutrophic conditions and consequently is not one of the major bog forming types. The general low occurrence of any *Sphagnum* species remains suggests that peat was not extensively collected for use on the crannog. The leaves of *Sphagnum palustre* may have been collected or have come from drinking water.

5.2. Grassland/Pasture Communities

Grassland growing today below the natural timber line in Scotland is all anthropogenic, having derived from the burning, felling and grazing of woodland (King & Nicholson 1964). The pollen record shows the entire pre-cultural Holocene landscape dominated by woodland with small scale clearances only up to and during the Bronze Age. Donner (1962), Tipping *et al.* (1993) and Tipping (1995) show the general reduction in the tree cover in Perthshire including Breadalbane, following the elm decline some 5000 BP, from a wooded landscape on the lower ground to one which is primarily open and ultimately almost treeless. The woodland clearance increased progressively with time and human activity, while grazing associated with settlements but also wild herbivores prevented the regeneration of trees. However at the time of Oakbank Crannog the level of domestic husbandry was still low, and the tree cover is thought to have been moderately good. The major agricultural clearances in Central Scotland were pre-Roman in origin (Ramsay 1995), but appear only to have been small scale and periodic until later on in the Highlands including Breadalbane (King & Nicholson 1964, Tipping *et al.* 1993). Nevertheless there would have been areas of forest cleared for arable and pastoral agriculture at the time of Oakbank Crannog as confirmed by the pollen records from Lochan nan Cat (Donner 1962) and the Killin axe factory (Tipping *et al.* 1993).

Within the broad classification of grassland/pasture described in table 5.1. there are several sub-categories which require specification. Pasture is vegetation which is tolerant of grazing and trampling. The floristic composition varies with topography, soil base status and drainage, although all types of grassland are dominated by members of the small Poaceae, except the high altitude grass-heaths where the Ericaceae are predominant. Rodwell (1991) and King & Nicholson (1964) summarise pasture categories according to soil and drainage. They emphasise *Agrostis-Festuca* and *Calluna*/grass mixed pasture, on moist and dry basic to mildly acidic soil, with grass-heath/moor communities on peaty humic soils of variable drainage. This latter category is typified by *Deschampsia flexuosa, Nardus stricta and Molinia caerula*, none of which were found at Oakbank. Sheep and goats have selective grazing habits which will consequently influence the grassland composition (King & Nicholson 1964). In recent centuries, overgrazing has resulted in higher proportions of unpalatable species such as *Molinia* and *Nardus* but the effects of intensive grazing are unlikely to have occurred in the Bronze/Iron Age. Experiments have also proven that in times of necessity (e.g. in winter) herbivores will turn to these distasteful grasses and other less favoured sources of food. Consequently the lack of *Molinia* or *Nardus* grasses in the Oakbank plant assemblage may not represent the absence of grass-moor/heath type of pasture on the higher slopes of Ben Lawers, but rather the preference for cutting lowland hay grown in the vicinity of the crannog which would not necessarily be supportive of these peat-favouring moorland species.

Agrostis-Festuca pasture indicators found at Oakbank included species indicative of both ends of the span from dry grassland to wet flushes, as well as many plants indicative of the range between. *Linum catharticum* suggests dry, base-rich soil, whereas *Poa trivialis, Ranunculus repens, Rumex acetosella, Sagina procumbens* and *Trifolium repens* are more frequent on wetter soils (King & Nicholson 1964). Other species from the Oakbank fossil assemblage which point towards damp and wetter grass communities include *Carex flacca* and *C. ovalis, Danthonia decumbens* and *Deschampsia cespitosa.* Moss species recognised from the site which grow in these wetter grassland areas include *Calliergon cuspidatum, Hylocomium splendens, Hypnum cupressiforme, Pleurozium schreberi, Rhytidiadelphus squarrosus* and *Thuidium tamariscinum.* Higher plants tolerant of a wider range of soil moisture conditions are *Plantago major, P. lanceolata, Poa annua, P. humilis, P. pratensis, Potentilla erecta, Prunella vulgaris*, *Ranunculus acris/bulbosus,* and *Veronica chamaedrys.*

The category of grassland/pasture also includes vegetation found in open woods, edges of pasture verging on wasteland and grass-heath. Classifying all these vegetation 'sub' types is a complicated issue. Consequently the general grassland/pasture category is taken here to include species which grow generally in grassy communities, without being too extreme in requirement for specific conditions such as acidity, shade or degree of waterlogging. The separation of grass-heath into this category from heath/mire is taken to include that type of heathland which contains large percentages of grass species along with dwarf shrubs of the Ericaceae. The macro-fossil evidence from Oakbank suggests areas of base-rich damp and fairly wet lowland pasture and waste grassland available for grazing and hay collection. Plant utilisation from higher up the hillsides is evident from *Calluna vulgaris* and other species to be discussed more fully later. This implies the possibility for transhumance of livestock to higher altitude grazing areas leaving lowland meadows for hay.

5.3. Arable/Waste Land Communities

Arable/waste communities have overwhelmingly human influenced origins, resulting in less ecological overlap with other categories than some. Nevertheless this is still a broad classification requiring explanation. Arable and waste ground present the wild plant communities with a condition in common, which is that the soil is frequently disturbed. Wild plants colonising these habitats are primarily dependent on this recurring disturbance to prevent competition from slower growing but ultimately more robust individuals, including perennial herbs and trees. The degree of disturbance the plants encounter influences the composition of disturbed habitat communities. Arable weeds are frequently annuals, the seeds of which ripen at the same time as the crop. The close similarity in size to cereal grains of many arable weed seeds, and the complex processes required to remove them means that in antiquity weeds were gathered with the crop assemblage, and a percentage of the seeds of these contaminant species would be sown the following year with cereal seed stocks. The methods of harvesting and processing of cereal crops will be considered in the section devoted to cereal cultivation

Methods of cultivation employed in the Late Bronze/Early Iron Age relied on wooden ard ploughing, the consequence of which was that the soil was turned over only very shallowly. This meant that an extensive weed flora could flourish, including those species which utilise vegetative propagation, although perhaps not as many types as the annuals. Shallow ploughing also kept the wild seed bank to within the top few centimetres of the soil. This depth is optimal for germination. It was not until the Iron Age that metal tipped plough shares were utilised (Jones 1981) and deep ploughing of the land became a reality. This resulted in a decrease in the amount of weed contamination, and consequently a better, fuller crop. The extensive weed flora at Oakbank indicates reliance on shallow wooden ard cultivation. This is confirmed by the ard share found on the site (Dixon 1984b).

Weeds found in crop assemblages often have seeds of a similar size to the crop and some nutritive value. Such seeds were gleaned out for animal fodder (e.g. Hillman 1981, 1984), or boosted the crops in times of want (e.g. Helbaek 1950, 1952, 1954, Hillman 1986, Holden 1986, 1995). The intentional saving of crop weeds for reasons such as fodder or food may artificially influence their abundance in arable areas. This must be considered when speculating about the natural background flora. Species found in association with crop assemblages and indicating agricultural practice that were present at Oakbank, often frequently, include *Anagallis* arvensis, *Aphanes arvensis s.l., Brassica rapa* ssp *campestris, Bromus* spp (including probably *B. hordeaceus*), *Chenopodium album, Cerastium glomeratum, Fallopia convolvulus, Galeopsis* subg *Galeopsis, Galium aparine, Heracleum sphondylium, Lapsana communis,* *Leontodon autumnalis/hispidus, Persicaria lapathifolia, P. maculosa, Prunella vulgaris, Ranunculus repens, Rumex crispus, Rumex obtusifolius, Sagina procumbens, Sonchus asper, Spergula arvensis,* and *Stellaria media.* The assemblage also included *Danthonia decumbens* and *Carex* spp, which although now are viewed as damp heathland plants, have frequently been recovered in ancient crop records, (e.g. Hall & Kenward 1990, van der Veen 1992) demonstrating that drainage and tillage methods were not as thorough as they are today.

Some arable weeds also grow in woodland areas and may not necessarily be crop contaminants, but enough of the species in the Oakbank macrofossil list are arable/waste obligates to indicate cultivation in the vicinity to the crannog for at least cereals. The high incidence of arable weeds suggests some of this was local, as imported crops would be highly gleaned to minimise waste. This point is discussed more fully chapter 7.

Cereals are known to have been grown at Oakbank, but may not necessarily have been the only crops, as legumes are not frequently encountered in the fossil record unless carbonised (Kenward & Hall 1995). Peas and beans do not need the same drying to process the crop as cereals, such that accidental burning is going to be a rarer event, and the large size of the crop seeds and method of harvesting means they would be more easily sorted. No human faeces were found on the site to analyse for epidermal fragments of this family, and there were also no seeds of wild Fabaceae herbs such as the vetches in the macrofossil list. The high protein value of these species as fodder has long been recognised, and the ecology of many of the members of this genus means some might be expected in hay assemblages. However, *Trifolium repens* flower parts have been found in samples representing fodder from hay. The petals of white clover are robust, which is why they have preserved, but this suggests that Fabaceae seeds in general may have suffered detrimental preservation. This could explain why crop legumes are lacking on the site.

Arable areas always have margins which are not cultivated as thoroughly as the main field. These support a community of species which have similar habitat requirements to the arable weeds, but need to be less disturbed to complete their life cycle. They are frequently biennials and short-lived perennials, although not exclusively, and of course the majority of arable weeds also grow in waste land environments. Species favouring waste places to arable land and found in the Oakbank assemblage include *Arctium lappa/minus, Centaurea nigra, Cerastium fontanum, Epilobium fontanum, Heracleum sphondylium, Holcus lanatus, Leontodon autumnalis/hispidus, Plantago lanceolata, P. major, Polygonum arenastrum, P. aviculare s.l., Prunella vulgaris, Rubus fruticosus s.l., Rumex* spp, *Sisymbrium officinale, Urtica dioica and Viola* subg *Melanium.* Waste land indicator plants suggest rough areas with disturbed soil around field margins, enclosures, and track-ways around the Oakbank settlement.

5.4. Heath/Mire Communities

Heathland vegetation as characterised by *Calluna vulgaris* will develop on acidic soils of low fertility with abundant rainfall and high humidity wherever forest is excluded, either naturally or anthropogenically. Indeed a canopy of heather will build up and maintain its own acidic humid environment to be self-preserving when mature and dense. However, on the more fertile soils, such as in Breadalbane, grassland has a competitive advantage over dwarf-shrub *Calluna*-heath. This occurs especially if it is grazed and in areas with moderate to good drainage (Gimingham 1972). Allied to the extensive tree cover in the Late Bronze/Early Iron Age, it is likely that grass-heath was probably more prevalent than heather in cleared lower altitude zones. This situation exists today, although greatly exaggerated by the dense sheep population. By implication dwarf-shrub heath would have existed mainly at higher altitudes in Bronze/Iron Age Breadalbane, but below the montane shrub-heath characterised by *Vaccinium* dominance (McVean 1964).

Low to mid altitude dwarf-shrub heath is mainly dominated by *Calluna vulgaris* which can be stunted and scattered over the canopy or form virtually pure stands over extensive areas. The species is the dominant component in a wide range of habitat conditions and consequently there is considerable floristic diversity in the communities established under its influence (Gimingham 1964). Leafy twigs, capsules and seeds of *Calluna vulgaris* at Oakbank attest to the species' presence in the area, as confirmed by the local pollen record (Donner 1962, Tipping *et al.* 1993). Other Ericales frequently abundant in *Calluna vulgaris* associations were also in the Oakbank macro-fossil record. These include *Erica tetralix, Vaccinium myrtillus/vitis-idaea,* and *Empetrum nigrum,* although they were never as frequent as the heather. This may be due to the fact that it is the berries for which the last two are selected, and human faeces were not recovered. Heather and heath are used for their vegetative parts. Discussion regarding the usefulness of specific plants to the Oakbank people will follow in chapter 7.

Herbaceous species frequently found in low to mid altitude dwarf-shrub heath community associations and also at Oakbank include *Danthonia decumbens, Deschampsia cespitosa, Potentilla erecta, Pteridium aquilinum, Selaginella selaginoides,* and various *Carex* species e.g. *Carex disticha, C. echinata, C. hostiana, C. panicea and C. pilulifera.* As mentioned previously the absence of *Molinia caerula* and *Nardus stricta* in this respect is surprising considering their frequency in these associations at present, but perhaps their absence is a reflection of human exploitation seen in the natural vegetation.

The distinction between heath and mire communities comes with the presence in the latter case of Bryophytes and herbaceous plants favouring conditions where the ground is permanently or periodically waterlogged to varying degrees (Rodwell 1991). The anaerobic conditions caused by the near surface water table in mire communities are unfavourable to decomposition of organic remains such that peat accumulates over time. Moss species that can inhabit mires from the Oakbank assemblage are *Sphagnum* spp including *S. palustre*, *Hylocomium splendens, Hypnum cupressiforme, Pleurozium schreberi,* and *Thuidium tamariscinum*, although all specifically mentioned here can also grow in other habitats, often woodland.

Sphagnum species have a unique ability to hold water and accelerate bog formation. The presence of these moss species in the Oakbank macrofossil assemblage indicates the proximity of the site to mire forming vegetation. Much of this mire is likely to be from the loch shore locality and wet woodland, but some mosses may have been brought from further away for their anthropogenic uses. As mentioned above, the identification to species of *Sphagnum palustre* does not imply acidic peat, but this may not be the only *Sphagnum* species present. There were only a few leaves in each of six samples, however, which cannot be taken to assume their use. Consequently the utilisation of peat appears low. This is perhaps not surprising given the availability of wood in the vicinity to the dwelling.

Bog-forming mire vegetation as distinct from fen and swamp adjacent to water-courses is dependent on topography and rainfall. Peat forms when dead plant material fails to decay due to constant or frequent waterlogging. Both the raised bogs of ill-drained basins and valleys and blanket bogs on slopes and plateaux in upland areas have resulted from the overgrowth of minerotrophic fen/swamp/carr areas, where the peat has accumulated to such a depth that there is no contact between the surface vegetation and the underlying mineral soil. Well established bogs are ombrotrophic, dependent on rainfall rather than ground water or streams for nutrients, which ensures a constantly low nutrient status that further favours the accumulation of strongly acidic peat.

Lowland mire classification follows a continuum from wet underfoot to fen and almost standing water, depending on topography and geology to give a localised concentration of ground water close to or at the surface for at least part of the year (Ratcliffe 1964). The availability of exchangeable calcium from parent rock determines the fertility levels they present (Ratcliffe 1964). The calcareous rocks of the Breadalbane area will result in areas of the rare eutrophic mire vegetation communities, but the proximity to the deep oligotrophic waters of Loch Tay suggests that the majority of mire vegetation represented here will be mesotrophic or poorer. However, many mire dominants have a wide tolerance to calcium and pH (Ratcliffe 1964), such that this condition may be hard to determine.

Mire vegetation at Oakbank is indicated by *Carex nigra, C. panicea* and *C. viridula s.l., Filipendula ulmaria, Galeopsis* subg *Galeopsis, Juncus* spp, *Montia fontana, Ranunculus repens, Rumex acetosella, Stachys palustris,* and

Viola palustris. Many of these species could grow in damp or much wetter areas, especially the *Ranunculus* spp and *Filipendula,* but are likely to have been present in open areas of the alder carr near the shores of the loch, at various water levels apart from the very edge of the loch. For ease of comprehension in this study plants which favour the wettest mire communities are classified in the fen/aquatic category. This includes the hydrophytic *Carex rostrata* which is more truly fen than mire. The identification to species of members of the genus *Carex* has facilitated this distinction, and highlights the importance in an ecological sense of specific identification of this problematic family. This fact is also relevant for the small Poaceae.

Blanket bogs are distinct from the lowland raised types in that they are usually formed over once wooded slopes and plateaux, beginning in response to the marked increase in rainfall caused by climatic change some 4-5000 years ago (Ratcliffe 1964). This transposed damp woodland into carr and favoured the growth of species from bog-forming genera including *Sphagnum*, and human interference prevented the regeneration of the woodlands. Species favouring bog habitats have a particular tolerance to acidity and low nutrient status, including, for example, certain *Sphagnum* species, *Calluna vulgaris, Eriophorum vaginatum and E. angustifolium.* No *Eriophorum* (cottongrass) species were present in the Oakbank assemblage which further lessens the possibility of significant peat collection on the site.

Rubus chamaemorus (see figure 3.14.) is also a constituent of bog assemblages, but is confined to montane blanket bog vegetation. Blanket bog covers upland areas in Breadalbane, and *Rubus chamaemorus* grows in suitable areas of the blanket peat above 700m altitude (Taylor 1971) (see figure 5.1.). Fruitstones of the species were found in two samples from the Oakbank macrofossil assemblage (see figure 3.15.). No other macrofossils found from the site are deep blanket peat obligates to such an extent as cloudberry. Consequently, the presence of fruitstones of this species on the site has implications for the long-range utilisation of land resources other than simply peat cutting.

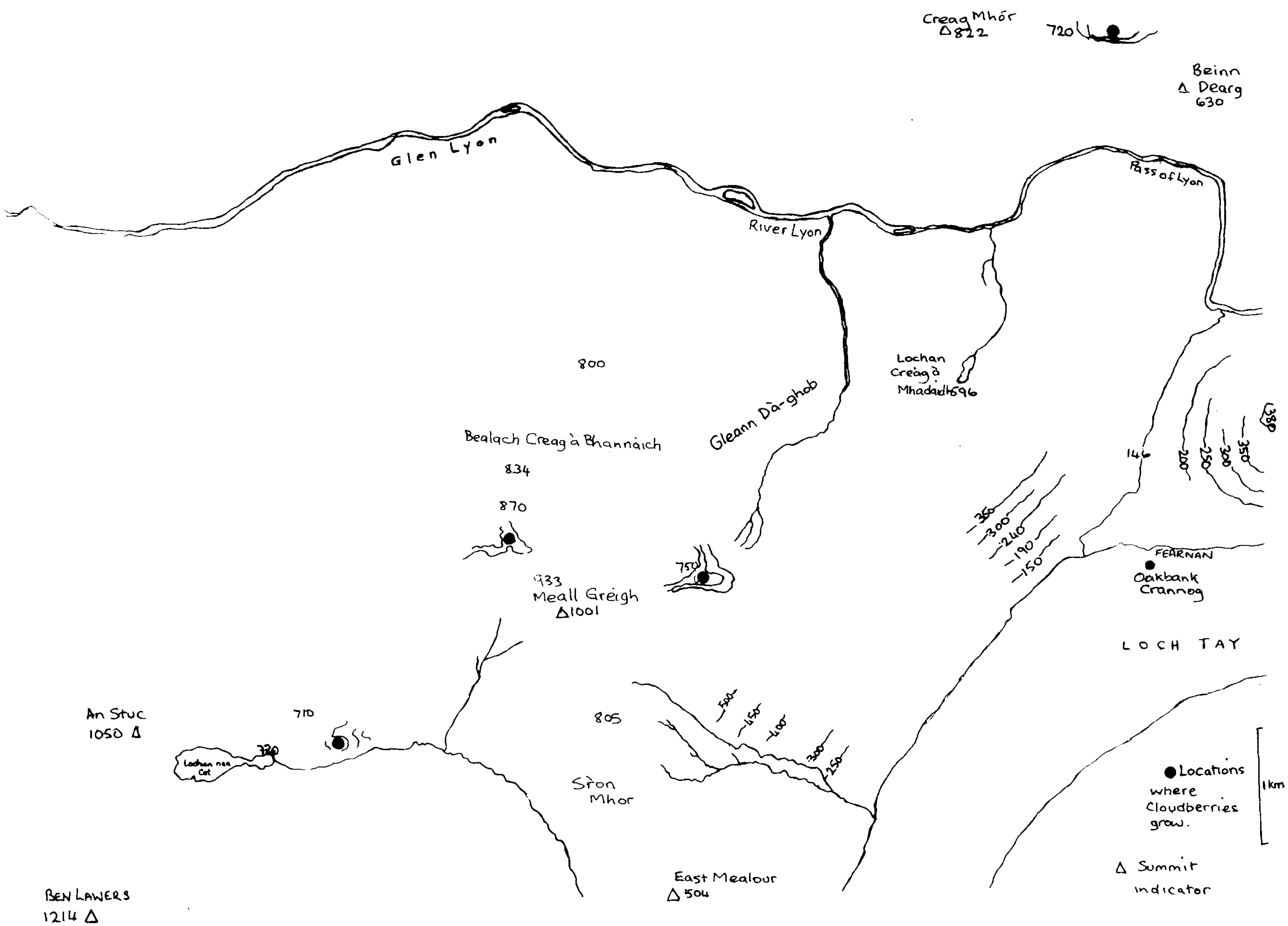


Figure 5.1. Map showing present day *Rubus chamaemorus* locations in Breadalbane

In general, the continuum from dry heath to ombrogenous bog covers all the possible species assemblages but allows speculation regarding the sorts of communities represented by the evidence at Oakbank. However, this can only be tentative and imprecise as there is a distinct overlap of species apart from at the extreme ends of the range (Rodwell 1991). Nevertheless it is possible to see representatives ranging from the damp low up to montane heath and mire communities present in Breadalbane.

5.5. Fen/Aquatic Communities

Fen communities merge with the vegetation marginal to water courses and standing water where the water table is above the ground level, resulting in submerged and floating obligate hydrophytes. If the ground is flat, the vegetation becomes swamp slightly further back from the watercourse, and ultimately succeeds into carr. Swamp is seasonally or permanently waterlogged and supports dense above-water plant cover (Ratcliffe 1964). Fen type communities on flood-plains, basins and valleys are frequently dominated by sedges and rushes, and some have been maintained for human use in the past (e.g. Godwin 1978). Without this active management the large flat fen areas can become overgrown in a scrub willow and alder carr succession. Few fen areas are extensive in Scotland due to the higher rainfall here which leads to bog formation, but some are fairly large in certain areas of England. The steep topography of the Lawers area around Loch Tay is also such that fen would not have been extensive, with only small areas likely at the south end of the loch where there is river inflow and consequently it is more eutrophic. It is for this reason that it can be said with some certainty that neither *Phragmites australis* (reed) or *Cladium mariscus* (great fen-sedge) were used as the main thatching material for Oakbank Crannog. The latter is rare and coastal in Scotland anyway (Perring & Walters 1976), so it would not be expected at Loch Tay. This would have involved long distance transport in the face of more readily available alternatives.

Fen habitats also include pond, loch side and muddy trackways species, such as would be present near the occupation site itself. Plants representative of this are present in the Oakbank assemblage, as would be expected from a crannog occupation site. These include *Callitriche stagnalis, Cardamine cf flexuosa, Carex rostrata, Juncus bufonius, Lycopus europaeus, Persicaria lapathifolia* and *P. maculosa, Rumex acetosella* and *Veronica beccabunga.* Some *Sphagnum* species also fit into the fen/aquatic category.

Accidental incorporation into the crannog of species from this vegetation classification would result from drinking water and mud on boots or animals' feet. Some species are more common in the fossil assemblage (e.g. *Juncus bufonius*) which may mean they were frequent in muddy areas adjacent to the causeway of the dwelling, as in medieval York (Hall 1986). *Rumex acetosella* also has flavouring possibilities and may have been collected. *Persicaria lapathifolia* and *P. maculosa* are more frequently encountered as arable/wasteland plants on ill-drained soil and are only included here for reasons of completeness. *Carex rostrata* can form dominant stands at the edges of lochs and ponds, and in semi-aquatic localities, in conjunction with *Phragmites australis* (reed) and *Filipendula ulmaria.* Few *Carex rostrata* remains at Oakbank may imply minimal use of the species as fodder in favour of something more palatable or convenient to gather, rather than rarity of the plant. As mentioned above, no evidence of *Phragmites australis* or *Cladium mariscus* was found at Oakbank. These species have been used frequently in the past for roofing material, including Glastonbury Iron Age village (Coles 1984, Housley 1986), and parts of the River Tay support flourishing reed beds, for example near Dundee. These latter were utilised on the crannog reconstruction at Kenmore. Neither reeds or great fen-sedges preserve well in the fossil record (Hall 1986), but their complete absence on the site where other fragile macrofossils have preserved suggests that neither species were used to thatch Oakbank crannog.

Fully aquatic plant species found include *Glyceria fluitans,* and *Isoetes cf lacustris.* The statoblasts of the Bryozoa *Cristatella* sp and *Plumatella furgosa,* ephippia (resting egg cases) of *Daphnia* species (water flea), and larval tubes of *Caddis* species were also found. The exposed, straight loch shores without inlets around the crannog site do not support dense growth of submerged species today, and the situation is unlikely to have been much different in the Late Bronze/Early Iron Age. This is further emphasised by the low fertility levels at the north side of the head of the loch. As a result, the scarcity of water-borne plant remains is not unexpected, and in fact the only species that could be said to have definitely come from the loch is *Isoetes cf lacustris*. Aquatic species found at Oakbank could have been incorporated into the assemblage through drinking water, the collection of wet silty mud for various purposes, or during the sinking of the crannog. Their scarcity means that valid information cannot be gained as to their status, if any, on the crannog. However, it does strengthen the argument that the crannog matrix samples are not unduly contaminated.

5.6. Unexpected Occurrences Within the Natural Vegetation Assemblages

The majority of species represented by the Oakbank macrofossil assemblage are common throughout Perthshire today, but some are noteworthy in being rare in the modern record as recorded by White (1898), Perring & Walters (1976) and Smith *et al.* (1992). Some of these are only present at Oakbank in one or two samples as single or few fossil seeds, for example *Agrimonia eupatoria, Aphanes arvensis s.l., Lycopus europaeus, Rumex sanguineus, Sagina apetala S. cf subulata* and *Torilis japonica.* The *Aphanes* and *Sagina* spp may have been overlooked in some field studies due to their extremely small size, but this cannot be true of all species or records. Their presence in the Oakbank macrofossil list may indicate a minimal past occurrence in Breadalbane. *Lycopus europaeus* is extremely rare or absent in the area today. It is also unknown today in Orkney yet it was in the Skara Brae assemblage (J.H. Dickson pers. comm.). The presence of seeds of the species in a Roman ditch at Bearsden (Dickson pers. comm. unpublished data) did not correspond with its local presence either. It may be that the plant was actively selected for dyeing from a small local presence (see chapter 7).

Other species which are rare or uncommon in modern records for the area occurred frequently in Oakbank samples. These include *Carex disticha, Fallopia convolvulus, Persicaria lapathifolia* and *Sonchus asper. Persicaria* *lapathifolia* may have been mis-identified as *Persicaria maculosa,* but It is suspected that some or all of these species may have been far more common in the past than they are today. This is most likely to be anthropogenic change as a result of differences in agricultural practice, including drainage and crop management.

Some macrofossils are only identifiable to either of two closely similar species on the basis of their seed morphology. In many cases this is not a problematic issue here, as frequently the two species are closely similar in terms of habitat and frequency of distribution (e.g. *Arctium lappa/minus, Betula pendula/pubescens, Juncus effusus/conglomeratus*). Others are more problematic in that one of the two species options is much rarer than the other. At Oakbank *Leontodon autumnalis/hispidus, Myosotis arvensis/sylvatica* and *Ranunculus acris/bulbosus* fall into this category, with the latter species option being unusual or rare compared to the first one. As it is not possible to adequately separate these species in the Oakbank macrofossils by reason of preservation or similarity, no further information regarding their possible status in and around the crannog can be obtained.

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Agrimonia eupatoria	1	ra		+	+			
Agrostis sp	13	co						+
Ajuga reptans	2	co	+	+				
Alnus glutinosa	15	co	+					
Anagallis cf arvensis	1	vr		+	+			
Aphanes arvensis	1	occ		+	+			
Aphanes inexpectata	3	occ		+	+			
Arctium lappa/minus	1	fq			+			
Avena sp	3				+			
Betula pendula	2	vc	+			+		
Betula pubescens	4	vc	+			+		
Betula sp	14		+			+		
Brassica rapa ssp campestris	8	occ			+			
Bromus hordeaceus	12	occ		+	+			
Callitriche stagnalis	1	fq					+	
Calluna vulgaris	8	vc				+		
Campanula rotundifolia	1	co				+		
Cardamine cf flexuosa	1	co	+					
Carex disticha	10	vr				+		
Carex echinata	10	vc				+		
Carex hostiana	10	fq				+		
Carex nigra	6	vc		+		+		
Carex flacca	1	co	+	+		+		

Table 5.1. Species with respect to habitats at Oakbank crannog (continues overleaf)

Note: Column 2 represents the number of samples out of a possible total 18 at Oakbank crannog in which each taxon was found. Where appropriate, column 3 shows each species' modern abundance in the Perthshire area today, after Perring & Walters (1976) and Smith *et al* (1992). In this column vr = very rare, ra = rare, occ = occasional, fq = frequent, co = common. Habitats of Bryozoa and other water-borne invertebrates follow those of higher plants.

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Carex ovalis	6	vc		+				
Carex panicea	4	vc				+		
Carex pilulifera	1	co				+		
Carex rostrata	2	co					+	
Carex sylvatica	5	fq	+					
Carex viridula s.l	10	co				+		
Centaurea nigra	1	vc			+			
Cerastium fontanum	12	vc		+	+			
Cerastium glomeratum	2	fq			+			
Chenopodium album	16	occ			+			
Corylus avellana	12	co	+					
Danthonia decumbens	7	fq				+		
Deschampsia cespitosa	13	vc	+	+		+		
Dryopteris felix-mas	1	co	+					
Empetrum nigrum	6	fq				+		
Epilobium montanum	1	co			+			
Erica tetralix	2	co				+		
Fallopia convolvulus	9	occ			+			
Filipendula ulmaria	7	vc				+	+	
Fragaria vesca	2	fq	+					
Galeopsis subg *Galeopsis*	17	fq			+	+		
Galium aparine	4	co			+			
Glyceria fluitans	5	fq				+	+	
Gnaphalium sp	1	fq				+		
Heracleum sphondylium	4	co		+	+			
Holcus lanatus	7	vc	+	+	+			
Holcus sp	5		+	+	+			
Hordeum vulgare s.l.	15				+			
Hypochoeris radicata	1	co		+				

Table 5.1. (continued)

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Isoetes cf lacustris	1	co					+	
Juncus articulatus/acutiflorus	11	co/co				+		
Juncus bufonius	13	co			+	+		
Juncus effusus/conglomeratus	17	vc/co				+		
Juncus squarrosus	1	co				+		
Lapsana communis	16	fq	+		+			
Leontodon autumnalis/hispidus	3	vc/vr		+	+			
Linum catharticum	9	co		+				
Linum usitatissimum	6				+			
Luzula sp	5							+
Luzula sylvatica	1	vc	+					
Lycopus europaeus	1	vr					+	
Montia fontana s.l.	2	co		+	+	+		
Myosotis arvensis/sylvatica	2	fq/ra	+	+				
Papaver somniferum	2	vr			+			
Papaver sp	2				+			
Persicaria lapathifolia	12	ra			+			
Persicaria maculosa	11	co			+			
Plantago lanceolata	8	vc		+	+			
Plantago major	7	co		+	+			
Poa annua	7	vc		+				
Poa humilis	6			+				
Poa pratensis	13	co		+				
Poa sp	11							+
Poa trivialis	10	co				+		
Polygonum arenastrum	2	overlooked			+			
Polygonum aviculare	1	fq			+			
Potentilla erecta	10	vc	+	+		+		
Potentilla sp	1							+
Primula vulgaris	1	co	+					

Table 5.1. (continued)

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Prunella vulgaris	15	co	+	+	+			
Prunus padus	2	fq	+					
Prunus sp	1		+					
Prunus spinosa	8	fq	+					
Pteridium aquilinum	17	vc	+	+		+		
Quercus sp	6		+					
Ranunculus acris/bulbosus	10	vc/occ		+				
Ranunculus flammula	11	co				+	+	
Ranunculus repens	13	vc	+	+	+			
Ranunculus sect *Ranunculus*	12							+
Rhinanthus minor	2	fq		+				
Rhinanthus sp	3			+				
Rosa cf canina	3	co	+					
Rosa sp	2		+					
Rubus chamaemorus	2	fq				+		
Rubus fruticosus s.l.	5	co	+		+			
Rubus idaeus	9	co	+					
Rumex acetosa	1	vc	+	+				
Rumex acetosella	5	co		+		+		
Rumex crispus	1	fq			+			
Rumex obtusifolius	1	co			+			
Rumex sanguineus	2	occ	+		+			
Sagina apetala	1	ra				+		
Sagina cf subulata	2	occ		+		+		
Sagina procumbens	3	co		+	+			
Sagina sp	3							+
Salix sp	2		+					
Selaginella selaginoides	1	fq		+		+		
Silene dioica	5	co	+					
Sisymbrium officinale	4	occ			+			

Table 5.1. (continued)

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Sonchus asper	14	occ			+			
Sorbus aucuparia	1	co	+					
Spergula arvensis	5	fq			+			
Stachys cf palustris	1	occ				+		
Stachys sylvatica	3	fq	+	+				
Stellaria graminea	12	co	+	+		+		
Stellaria media	12	co			+			
Stellaria sp	1							+
Torilis japonica	3	occ		+				
Trifolium repens	6	co		+				
Triticum dicoccum	8				+			
Triticum sp					+			
Triticum spelta	10				+			
Triticum/Secale sp	12				+			
Ulmus sp	2		+					
Urtica dioica	17	co	+		+			
Vaccinium myrtillus/vitis-idaea	4	vc/fq	+			+		
Valeriana officinalis	1	co		+	+			
Veronica beccabunga	1	co				+	+	
Veronica chamaedrys	3	co	+	+				
Veronica sp	1							+
Viola palustris	1	co				+		
Viola sp	6							+
Viola subg Melanium	3			+	+			
Viola subg viola	3		+	+		+		
Bryozoa and invertebrates								
caddis fly larvae tubes	7						+	
Cristatella sp	1						+	
Daphnia sp ephippia	2						+	
Plumatella furgosa	1						+	

Species name	number of samples in	modern abundance	wood/ scrub	grassland/ pasture	arable/waste	heath/ mire	waterside/ aquatic	indet
Antitrichia curtipendula	1	locally vc	+					
Calliergon cuspidatum	1	vc	+	+		+		
Eurynchium cf striatum	1	co	+					
Eurynchium sp	3							
Hylocomium splendens	8	vc	+	+		+		
Hypnum cupressiforme	5	vc	+	+		+		
Neckera complanata	11	co	+					
Pleurozium schreberi	1	vc	+	+		+		
Rhytidiadelphus squarrosus	1	vc	+	+				
Sphagnum palustre	1	vc	+					
Sphagnum spp	6		+			+	+	
Thuidium tamariscinum	4	vc	+	+		+		

Table 5.2. Moss species identified at Oakbank crannog

Note: Column 2 represents the number of samples out of a possible total 18 at Oakbank crannog in which each taxon was found. Where appropriate, column 3 shows each species' modern abundance in the Perthshire area today, after Hill *et al.* (1992 & 1994). In this column vr = very rare, ra = rare, occ = occasional, fq = frequent, co = common.

CHAPTER 6: WOOD AND CHARCOAL

6.1. Wood Identification and Species Use

Wood is one of the most important natural resources that was known to early man, providing shelter, fuel, and a wide range of other daily necessities. The identification of wood species found in archaeological contexts is important to explain past woodland cover and the utilisation of forestry by ancient communities. Wood-working is a craft which requires an understanding of the anatomy of trees and a knowledge of the differential properties of the various species. In some cases the same trunk can yield perishable sap wood which will decay after a few years and durable heart wood which may outlast iron. Different trees have distinct qualities of strength, weight, texture, flexibility, seasoning and chemical constituents, such that various types are more or less suitable for particular jobs. Trees supply timbers for housing, wood for carving into tools, weapons and artefacts, flexible rods for wattle and basketry, bark for rope and tanning, dyes, chemical constituents for balms and ointments, and other colloquial uses.

6.1.1. Properties of Woods

The formation of annual rings in a particular species varies with age, part of the stem, climate fluctuations, availability of minerals, and growth location (Schwankl 1957). Generally young and middle-aged individuals have broader rings than old or mature ones (Schwankl 1957), but this phenomenon may be countered by adverse conditions of climate. Some species (e.g. oak) produce growth rings at a steady rate, more or less independent of local climate, but others such as alder are much more sensitive to local conditions and may not produce a growth ring at all some years in some areas. This means that alder cannot be used to construct an absolute chronology (Crone 1988) in the way that oak has been so successfully utilised. This fact is unfortunate for a waterlogged site such as Oakbank crannog where the majority of constructional timbers are alder. Coppicing also affects the average diameter of shoots.

The coppicing of a tree produces prolific shoots which individually are much narrower than normal (Schwankl 1957, Edlin 1973), and have a uniform width down the length of the stem. Coles (1987) describes these features in coppiced shoots from the Somerset Levels trackways.

A general distinction can be made between broad ringed fast growing soft wood species such as the conifers which have relatively more spring wood and less summer wood than the slower growing hard wood trees. These hard wood species have more of the robust, dense summer wood and less of the porous spring wood, (Schwankl 1957) which means they are more resilient, but in economic terms are a more expensive, slower crop to produce. The "hardness" of a particular tree is related to its specific gravity (SPG), in other words its weight per unit volume. This is defined by its internal anatomy. It is the SPG that determines the durability, firmness, working properties, and ultimately its uses. Figure 6.1. shows a list of the species found at Oakbank by this author and their SPG (after Schwankl 1957), tallied to their frequency of occurrence throughout the site in general. From this table it can be seen that alder is a softer and more easily worked wood than oak. This may account in part for the preference for alder for both structures and artefacts, although it is likely that availability for use is equally important, especially where large timbers are concerned.

Species	Specific Gravity	Frequency at Oakbank
Salix sp	0.46	ra
Alnus sp	0.53	dom
Betula pendula/pubescens	0.61	co
Corylus sp	0.63	ab
Quercus sp	0.70	occ
Pomoideae (*cf. Sorbus*)	0.7	ra
Prunus spinosa type	0.81	ra
Where the specific gravity of water is 1.0.		

Figure 6.1. List of tree species found at Oakbank and their specific gravity (after Schwankl 1957)

6.1.2. Wood Species Selection at Oakbank

Simplistically, the mean increase in girth of a tree in full crown averages 25mm per annum (Mitchell 1996) when taken over a prolonged period. However, the width of the bole varies with the amount of space and light available, such that an individual in a forest situation may be up to 100 years older than one with a similar girth in full crown and adequate space. (Mitchell 1996). This has implications for the situation found at Oakbank crannog, where the piles were long, straight maiden trees, mainly alders and oaks, taken from a forest situation and thereby likely to have been of a good age. The regeneration of this woodland could not be achieved satisfactorily with any sustained human impact. The forest clearance of central Scotland is now recognised to have occurred during the pre-Roman Iron age (Ramsay 1995), and what is in evidence here is just such a foray into the pre-cultural landscape, albeit further North.

The wood found at Oakbank from within organic matrix deposits by this author was in the form of roundwood fragments and wood-working waste chips. Species were primarily *Alnus, Corylus, Betula* and *Quercus* species, with *Salix,* Pomoideae (*cf Sorbus*) and *Prunus spinosa* type present in descending order. No coniferous wood was found by this author. Sands (1994) found this same species list in his intensive examination of wood from the Oakbank structural uprights, horizontals, wood-working waste and artefacts, but with the addition of low quantities of tapers of *Pinus sylvestris* (Scots pine), one horizontal of *Fraxinus* (ash), and worked chips of *Hedera helix* (ivy), *Sambucus nigra* (elder) and *Sorbus aucuparia* (rowan). 2% *Ulmus* sp was in the form of the occasional pile and chips. Elm cannot be identified to species on the basis of its wood anatomy (Schweingruber 1990) and *Ulmus* sp wood is rarely found in waterlogged deposits of this age (Schweingruber 1982). It has been found in the form of axe handles and posts. Coles *et al.* (1978) site its presence in the archaeological record as coffin planks, a use which continued until fairly recently (Edlin 1973). The incidence of elm pollen in the Breadalbane area never went above 10% A.P. according to the post-glacial silts from the margin of Lochan nan Cat (Donner 1962), and the species was consequently not a major forest component. Nevertheless Elm has a great tolerance to continuous waterlogging, although not withstanding wetting and drying repeatedly (Edlin 1973), and would be a good choice if selected for a submerged position. However one or two elms is more likely to reflect casual use of whatever trees were to hand. No elm wood chips were found by this author, although occasional charcoal fragments have been recovered from area C6.

Dixon (1984b) and Sands (1994) describe some *Pinus sylvestris*, in the form of charred tapers. Sands also found one worked chip suggestive of other, unknown uses. With its high resin content, pine is well known for torch making and fire-lighting. No *Pinus* wood or charcoal has been found in samples examined by this author. Very little charred material of any description has been found in these samples, implying that the hearth contents are not well represented. This may be why pine is not found, and if so, highlights the differential uses of tree species.

Structural piles (see figure 6.2.), worked wood chips and roundwood trimmings have been found in abundance at Oakbank generally, along with twigs, bark, and artefacts demonstrating the excellent woodworking skills of these prehistoric people. One particularly fine *Alnus* plate has such ornate carving that there is the suggestion that its use was for other than everyday use. The comparison with rough hewn tableware from the same site is obvious (Dixon 1984b). Alder wood was a popular choice for ancient tableware (Coles *et al.* 1978) and was used at Oakbank for many artefacts including a canoe paddle and butter dish (Dixon 1984b).

The excavation of the Oakbank site has revealed that the large structural timbers had points cut on to them before they were driven into the loch, and some also still retain the mortise joints built to hold the structure together. Other crannogs show this feature too. e.g. crannogs at Loch Bruiach (Blundell 1910), Milton Loch 1, (Piggott 1953), Lochlee, Lochspouts, Buiston and others (Munro 1882). Recent work at Oakbank has determined the possibility of tracing the signature marks found on the structural timbers to particular axes and by implication to the same phase of construction (Sands 1994). This has been proven to work more effectively with soft alder wood than the harder oak (see figure 6.1. above) which also has the added complication of large spring vessels. Consequently this technique is most useful for a site such as Oakbank crannog where the construction is primarily of alder.

6.1.3. Wood Found at Oakbank and Implications for its Uses

The number of fragments of each species and their size ranges from each sample are illustrated in table 6.1.

Quercus sp (oak) In the absence of competition, the native oaks *Quercus petraea* and *Q. robur* will attain 42m and 37m in height respectively (Stace 1991), with a diameter of 10 feet or more to the bole (Schwankl 1957). The species cannot be distinguished on the basis of their wood anatomy (Schweingruber 1990), and hybridise to produce fertile progeny (Stace1991). Consequently specific identification at Oakbank is not possible. Both grow on a wide range of soils, although *Q. petraea* tolerates shallow, sandy to acid soils and higher altitudes rather better than *Q. robur* (Stace 1991). It might be more common in a wet alder/oak woodland, but not necessarily.

The heart wood of oak in general is extremely durable, due to the presence of tyloses and tannin which block the heartwood vessels and prevent invasion of necrotising bacteria and fungi. The oak piles on Oakbank crannog are a testament to the durability of its heart wood. Conversely, oak sap wood is not resistant to decay (Edlin 1973), having large spring vessels. As the outer sap wood does not preserve well when exposed to alternating wetting and drying, the outermost few years will be absent in many cases. This has detrimental implications for dendrochronology. *Quercus* has a high SPG, making it suitable for housing, furniture, boats, bridges, and all manner of small, artefacts which need to be strong, such as building dowels and wheel spokes. Its abundance in the fossil record is well known (e.g.. Coles *et al.* 1978, and notifications from numerous crannogs and lake settlements, including Keller 1866, Munro 1882, Wood-Martin 1886, Piggott 1953, authors in Coles 1987, Crone 1991).

81A3S4	3 *Alnus* sp (chips), 20-25mm **23 *Corylus* sp (round), 20-125 x 5-22mm, 3-12 growth rings**
87C6S1	3 *Alnus* sp (chips), 40-75 x 25-41 x 6-10mm. **1 (round) 15 x 5mm** 39 *Alnus/Betula* sp indet. (chips) 5-15 x 5-10 x 4-6mm **41 *Betula* sp (round), 20-30x3-5mm, 1-4 growth rings,** 2 (chips) 22-44 x 20-40 x 8-10mm **1 *Corylus* sp (round) 10mm diameter**
87C6S5	2 *Alnus* sp (chips) 10-11 x 10 x 3-5mm 1 *Betula* sp bark roll 30 x 10mm 6 *Quercus* sp (chips) 40-50 x 18-24 x 4-10mm
91C1S008	**1 *Prunus spinosa* type (round) 30 x 8mm**
91C1S6	**1 Pomoideae (*cf Sorbus* sp) (round) 75 x 10mm**
91C2S7	1 *Alnus* sp (chip) 20 x 5 x 3mm 3 *Betula* sp (chips) 10-58 x 10-15 x 4-6mm 3 *Betula* sp bark rolls 50 x 20-50mm **2 *Corylus* sp (round) 20-25 x 10mm, 6-7 growth rings.** 1 (chip) 50 x 35 x 4mm 2 *Quercus* sp (chips) 10-22 x 10 x 4-5mm 2 *Salix* sp (chips) 30-45 x 4-5 x 4-5mm
94C6S2	4 *Alnus* sp (chips) 10-75 x 25-51 x 4-9mm. 1 bark fgmt 190 x 60 x 10mm 1 *Betula* sp (chip) 45 x 20 x 3mm **4 *Corylus* sp (round) 58-115 x 5-18mm, 2-7 growth rings** 1 *Quercus* sp (chip) 30 x 20 x 8mm
94A2S5	**10 *Alnus* sp(round) 15-40 x 3-5mm, 1-2growth rings** **10 *Betula* sp (round) 10-35 x 3-5mm, 1-2 growth rings**
94D2S7	**1*Alnus* sp (round) 55 x 30mm, 10growth rings.** 1 (chip) 28 x 45 x 7mm **6 *Betula* sp (round) 60-160 x 15-31mm, 12-15growth rings.** 1 (chip) 13 x 10 x 4mm **39 *Corylus* sp (round) 30-115 x 5-27mm, 3-14growth rings (average 6/7)** 1 *Salix* sp (chip) 5 x 6 x 4mm
94B4S8	**1 *Alnus* sp (round) 12 x 3mm, 2-3 growth rings** **1 *Betula* sp (round) 68 x 18mm.** 1 (chip) 40 x 10 x 4mm **9 *Corylus* sp (round) 35-190 x 10-26mm, 6-14growth rings** **3 *Quercus* sp (round) 126-170 x 24-31mm, 7-8growth rings.** 1(chip) 22 x 20 x 4mm 1 *cf Quercus* sp (bog) (chip) 70 x 10 x 4mm
94C6S9	**1 *Alnus* sp (round) 75 x 5mm, 2growth rings.** 1(chip) 35 x 15 x 4mm 1 *Alnus/Betula* sp (chip) 40 x 10 x 6mm, very eroded **1 *Corylus* sp (round) 70 x 20mm** 1 *cf Quercus* sp (chip) (bog) 30 x 15 x 3mm

Table 6.1. Number and sizes of wood fragments isolated from matrix contexts at Oakbank crannog by the author.

Round wood is in bold type, worked chips with one or more cut faces are in normal type. The number of growth rings is given where possible. This approximates to the age in years of the fragments.

The high SPG of oak makes it less easily worked than other lighter woods such as *Alnus*, so it would not have been favoured at Oakbank for intricate carving in the presence of these softer species unless its durability were required. The oak found at Oakbank by Dixon (1984b) and Sands (1994) was in the form of piles (including most of the forty causeway timbers), worked chips and points, emphasising this requirement for resilience. Much of the oak found during this study is of a similar nature also. Sands (1994) has recreated the tool-kit used by the Late Bronze/Early Iron Age Oakbank inhabitants using the tool signatures. He concluded that the equipment used was basic but serviceable. It is not surprising that the more easily worked species were used for intricate carving whenever possible. The (*cf*) rosewood whistle is an exception to this, however (see figure 6.1.).

Small chips of *Quercus*, with and without bark, represent wood trimmings possibly from various activities on the site. Some of the oak chips displayed the characteristic tyloses which are diagnostic of heartwood. As oak heartwood is extremely resilient and durable it is suggested that the wood chips found in this context are from larger pieces intended for structural use. Their deposition on the site may have resulted from *in-situ* mortise joint cutting or the utilisation of worked chips for various purposes including raising uneven floors or drying damp areas. Sands (1994) took 5-800 blows to reconstruct a pile point with 100 facets. Clearly wood chips would have been an abundant resource.

If continually waterlogged oak may eventually become ‘bog’ oak, a result of the tannin in the vessels “fossilising” it. Some of the Oakbank construction timbers show this phenomenon, and occasional worked chips do too. The topography of the landscape is such that these are unlikely to have been worked from bog-oak, but have become so after deposition.

Three roundwood pieces of *Quercus* from sample 94B4S8 were around 30mm in diameter by 130-170 mm, long, cut cleanly across both ends, and complete with bark. They were approximately eight or so years old. These may be the remains of peg-making activity on the crannog. Pegs were used on the dwelling in all places where nails would be employed today. Very similar such pieces of wood were strewn about the site of the crannog reconstruction at Kenmore when the volunteers were employed in this manufacture.

Alnus sp (alder) The only native British species of alder is *Alnus glutinosa* (Stace 1991), but this cannot be isolated on the basis of its wood anatomy (Schweingruber 1990). However, any wood identified from Oakbank is likely to be *Alnus glutinosa*. It is referred to as alder (*Alnus* sp) in recognition of the potential for traded items, especially where artefacts are concerned.

The majority of wooden artefacts and worked chips found at Oakbank both by this author and others (Dixon 1984b, Crone 1988, Sands 1994) have been *Alnus* sp These studies have revealed that the majority of the structural timbers involved in the fabric of the building itself are *Alnus* sp but unfortunately the growth habits of the trees was too inconsistent to produce a satisfactory absolute chronology Crone (1988). Nevertheless a relative chronology was calculated and Sands (1994) compared this with groups of tool signatures he had devised, enabling him to calculate building phases and approximate time scales involved for these. Clearly this combination of dendrochronology and signature groupings has implications for future work. Nevertheless it is unfortunate that most dendrochronological work has been done on oak, and no mature oak retained a good signature at Oakbank (Sands 1994).

Straight, long alder timbers implies close growing unmanaged woodland with maiden trees. Alder grows beside water and in damp woodland, as would be in evidence around the crannog site. Clearance of flat areas of the "Wildwood" envisaged by Rackham (1976), consisting primarily of maiden alder and oak, with hazel, birch and occasionally ash and elm, would provide the crannog builders with ideal house building materials and fertile ground for crop growing. The high incidence of damp tolerant weeds in household contexts is a testament to the likelihood of a significant proportion of the arable land having a high water content. Another benefit of using alder comes from its proximity to the loch which means it can be floated out to the construction site without too much energy expended.

Alder wood is extremely tolerant to alternate wetting and drying. (Schwankl 1957, Edlin 1973, Mitchell 1996) partly as a result of its tannin content. Morrison (1985) argues that any timber built crannog would require continuous refurbishment, but this effect must have been minimised by a careful choice of construction timbers, such as are displayed at Oakbank and other crannogs, as discussed previously. Certainly there is only clear evidence for a few major phases of consolidation on the site (Dixon 1984b, Sands 1994). More recently, alder has formed waterside pilings, including the pier for the Loch Tay ferry, still standing after more than 100 years. The frequency of Alder on a waterside site, coupled with a dwindling of the less prolific oak resource as the trees are cut down will also account for the extremely high values of this species found compared to others. A nucleus of oak trees in the crannog vicinity may have been kept to provide acorn fodder for livestock.

The soft nature of alder wood enables it to be carved easily into small items which require resistance to alternate wetting and drying, such as clogs, scrubbing brushes, and bowls (Edlin 1973, Coles *et al.* 1978). Intricately carved and rougher plates, a possible spoon, canoe paddle, and a butter dish have been found at Oakbank (Dixon 1984b)

Many of the alder chips found in context with household detritus during the course of this study are of a wedged or square shape and size suggestive of fashioning a point or mortise joint onto a timber for a pile or stake. Such wood-working waste would be characteristic of construction, consolidation, and reconstruction of an existing dwelling, although the larger construction piles are likely to have been shaped on land. (Coles *et al.* 1978). As mentioned previously, chips from wood-working would have had a multitude of uses in the dwelling.

Few small alder twigs were found in any of the samples analysed for wood, although the occasional discovery of *Alnus glutinosa* fruits on site implies the presence of false cones, and therefore probably branches. The large timbers may have been trimmed before they reached the crannog, at least roughly, but as much of the charcoal found on site by this author is alder, this may be where many of the small to medium sized branches and twigs went.

The use of branch trimmings for firing makes economic sense. Many of the structural timbers were undressed wood, with bark extant, (Dixon 1984b, and the large flat plates of alder bark from sample 94C6S2). This does not necessarily mean the wood was used green, however, as unseasoned wood is extremely heavy compared to that which has seasoned for several months (Schwankl 1957). Seasoning involves removing occasional patches of bark to allow air into the sap wood (Edlin 1973). This is possibly the case at Oakbank. Other small wood chips also exhibit axe marks, and may be fine trimmings from any number of purposes.

Alder wood makes good charcoal for smelting purposes (Edlin 1973) It has been found in the same context as metalworking slag at Oakbank (90E2S5), but not in significant enough quantities to imply specificity of use.

Betula sp (birch) The two native birch tree species, *Betula pubescens* and *B. pendula* stand some 24 and 30m high respectively (Stace 1991), with an upwardly curving stem, less than 40cm thick (Schwankl 1957). The two hybridise freely (Stace 1991) and cannot be separated on the basis of their wood anatomy (Schweingruber 1990). They require light and do not compete well in the dense shade of mature forest, such that they are confined to the margins or open woodland in a similar manner to *Corylus*. In newly cleared areas birch is a pioneer, but grazing pressure eliminates replenishment of seedlings. The pollen record for the area shows high levels of *Betula* and *Corylus* pollen (Donner 1962), and consequently relatively large areas of open woodland. The incidence of piles and worked wood chips of birch wood at Oakbank from both this study and Sands' is not as high as that of alder and oak, but this is to be expected as the tree is not so ideal for large structural use due to its smaller stature. It lends itself more readily to small item turnery (Edlin 1973).This is borne out by the fossil record, as outlined by Coles *et al.* (1978).

In this study, the incidence of narrow circumference birch twigs and rods was higher than that of angular chips, reflecting possible basketry and wattle uses. The species occurs in context with hazel roundwood from a possible hurdle in sample 91C2S7, and Sands (1994) noted fragments of hazel hurdle in

A2. Past common uses for small birch twigs include also bedding, roofing thatch, brooms, and rope made from the twisted fine spray (Edlin 1973). The incidence of birch twigs is not sufficiently high enough to suggest thatch or bedding at Oakbank, but twisted birch wood rope is suggested from aggregations of small twigs found in locations 87C6S1 and 94A5S2. Birch charcoal is more common than worked wood chips and the species may have been gathered for firewood and kindling more frequently than for other uses.

Evidence for large birch bark is scant (91C22S7) compared to that of alder. This precludes any major use such as the under thatch suggested at Papa Stour (Dickson, unpublished) but small baskets such as that carried by the Tyrolean iceman (Oeggl & Schoch 1995), and photographed particularly well in Egg *et al* (1993) cannot be discounted.

Corylus sp (hazel) The native *Corylus avellana* cannot be separated from introduced species by wood characteristics (Schweingruber 1990), but is the likely origin of samples from Oakbank. Hazel accounts for more than 90% of all the roundwood over 2 years old found in samples investigated by the author. The incidence of Corylus pollen in the Breadalbane area was high in the late Bronze and early Iron Age (Donner 1962) confirming its likely frequency of occurrence at Oakbank. The clean cut nature of the wood, and the locations they were found in, are often directly attributable to wattle and hurdles from external walls or internal partitions. Wattle waste on the site is evident from the axe marked ends and knots found. These small trimmings of round hazel wood imply ongoing house repairs. Interestingly, much of the hazel shows evidence suggestive of coppicing, namely narrow growth rings and straight rods, with an average age of 6-8 years (see Coles 1987). These have been found in context with rods of approximately 12 year ages, such as would be required for uprights. Recent coppices involve a 7 year cycle (Edlin 1973). The suggestion is that the earliest settlers moved into the area and began managing their environment, producing abundant hazel rods for a multitude of purposes. Other possible uses for hazel rods are thatching spars (Fenton 1978) and fishing traps (Edlin 1973).

<u>*Salix* sp (willow)</u> Identification of *Salix* sp wood is not able to be done to species (Schweingruber 1990) and is further complicated by the degree of hybridisation between different types (Stace 1991). Wood identified here is only recognised to *Salix alba* agg.

Willow wood is uncommon in samples analysed to date by this author, although 2 *Salix* piles are recorded from the site (Sands 1994). This concurs with the comparative scarcity of willow pollen in the regional area (Donner 1962) and trace levels only in the Clapham and Scaife (1988) core, but cannot signify quantities of trees, as insect pollinated species never show high levels. Low quantities of willow wood at Oakbank is more likely to imply selective usage of species or differential preservation. Willow is likely to be fairly common in marginal tracts of areas favoured by alder, where water levels are high in the soil.

<u>Pomoideae</u> One piece of Pomoideae wood found in 91C6S1 is likely to be *Sorbus* sp but was not preserved sufficiently to ensure absolute identification. Rare *Sorbus* (rowan or whitebeam) charcoal has also been found in C6 contexts. It is not possible to differentiate between *S. aucuparia* (rowan) and *S. aria* (whitebeam) on the basis of their wood anatomy (Schweingruber 1990) and both are native (Stace 1991). However any *Sorbus* sp found is likely to be *S. aucuparia*, as *S. aria* has never been common in Scotland (Perring and Walters 1976). Two *Sorbus* upright timber stakes, one horizontal and several waste chips are previously recorded from the site (Sands 1994) which were taken to be *S. aucuparia*. This author is cautious about making such an assumption given the reasons outlined above.

<u>*Prunus spinosa* (sloe) type</u> One cut marked roundwood fork of *Prunus spinosa* type from 91C1S8 reflects the minority usage of fruit wood for selective purposes. Chance incorporation cannot be discounted. A *Rosa/Prunus spinosa* type species whistle, and Rosaceae bucket stave have also been found on the site (Dixon 1982a).

Ulmus sp (elm) The structure and uses of elm have been discussed above. No wood fragments of elm were found by this author, but occasional charcoal fragments attest to its low presence. Sands (1994) found *Ulmus* sp wood as rare piles and waste, but Skinner (1984) observed both *Ulmus glabra* and *U. procera*. In the absence of detailed information on the characters used for identification, however, these identifications must be treated cautiously since specific identification of elm is unlikely (Schweingruber 1990), and *U. procera* is introduced in Scotland (Stace 1991).

6.2. Charcoal Identification

In many archaeological contexts wood charcoal with occasional charred seeds and bone is the only environmental evidence remaining. This is because many sites lack the high water table necessary to preserve waterlogged material. As this is not an issue at Oakbank, the evidence from the charcoal identification serves to highlight what is already a very comprehensive picture. Charcoal and charred wood of species including alder, birch, hazel, oak and pine have already been noted by Dixon (1984b). Little charcoal has been found by this author compared to the levels of wood on the site, suggesting that the successive hearth locations were not in the immediate vicinity to the samples analysed. A noticeable charcoal scatter was noted during the excavation of areas C1 and C2, where there has been some collapse, and it is suspected that the hearth area may have been in this region. The charcoal found embedded in the organic matrix samples by this author is of a level commensurate with accidental general scatter mixed with waste from the occupation level floor.

Carbonised wood species found in the samples analysed for this project mimic those of the comprehensive wood study undertaken to such an extent that only a representative arbitrary number were studied from each sample. All pieces were examined to see if they were ring or diffuse porous. Ring porous fragments were never very numerous compared to the diffuse porous ones. The total number of pieces analysed was dependent on the size of the whole sample and the diversity within it. The only additional species able to be added to the list of wood types were *Ulmus* and *Sorbus* species. The results of the charcoal analysis are shown in tables 6.2. and 6.3

6.2.1. Charcoal Results

From the results given in tables 6.2. and 6.3 it can be surmised that alder was used for burning as well as the many other general purposes devised for it on site. Other species were also well represented, especially birch and hazel. Much of the hazel was in the form of roundwood rods, and may represent waste from hurdle making or rod coppicing being used for firewood. Other species suggest the efficient use of wood-working waste and intentional firewood gathering. The fire is the focal point in a house, especially one built in a draughty location in a loch. No hearth has been located at Oakbank, as mentioned above, but it is likely that this would have been fed fuel on a continuous basis to keep the embers glowing. Certainly fire-making equipment including stones with hollows for rubbing-sticks were present on the site (Dixon pers. comm.).

Although much of the charcoal from the site undoubtedly comes from wood burned on the fire, there is the possibility that some was intentionally made into charcoal for purposes requiring fires with a higher temperature than a domestic wood fire can produce. This is likely to have occurred on land as it would be a dangerous practice on a wooden crannog. In sample 90E2S5 for example, the charcoal was in context with bubbles of metal working slag drips (see figure 6.3.). Without chemical analysis of the sort employed at Lough Faughan Crannog (Collins 1955) it is not possible to say whether iron or copper smelting was done in the area. Nevertheless the slag had the general appearance of the 'tap slag' formed during iron smelting, where the impurities in the ore melt at a lower temperature than the iron metal, and can be run off in a liquid state to a trap below, leaving a mound of iron 'sponge' which can be hammered to remove further molten impurities (Tylecote 1962). As iron melts at 1540°C, and the slag is molten at 1150°C (Tylecote 1962), this can be achieved without loss of metal. An iron blade found near A2 on the site emphasises the iron working potential of the inhabitants, and many of the axes used for the manufacture of the dwelling were iron (Sands1994). Slag from copper ore used in the manufacture of copper for bronze has a different appearance in that it remains in the porous covered crucible employed to smelt it and reduce the copper oxide in the ore to molten metal (Tylecote 1962). Slag here frequently does not have the appearance of frothy hardened 'drips' in the way that iron slag often does. The Oakbank slag drips had such a resemblance, and are suspected to be iron.

Whatever metal was being worked, whether for smelting or melting metals for alloy, the requirement for charcoal on site is highlighted, as it burns at a higher temperature than wood. Smelting copper requires temperatures in excess of 400^{0}C which can be just about achieved on an open bonfire, using a porous, covered crucible to prevent oxidation of the metal, but iron requires temperatures above 800^{0}C, requiring either bellows on a mound of charcoal or a purpose-built furnace (Tylecote 1962). Such a device has not been found at Oakbank, but this is perhaps not surprising on a wooden construction with dry land nearby. The fire on the crannog may have been for mainly domestic use, with either small scale smelting or reuse of charcoal left unburned from smelting elsewhere, on to which slag had dripped. The drips and charcoal may represent this or be dumped waste from another area. In terms of species thought to burn at satisfactory temperatures for smelting, Edlin (1973) recommends alder or oak charcoal.

Birch and hazel were also burned frequently at Oakbank, and have often been found in the same context as alder, suggesting that wood may not have been selected for burning with any more thought than what was available and plentiful. It is most likely that waste from wattle and wood-working was burned. Almost all *Corylus* charcoal is in the form of cut roundwood, or fragments of such. *Betula* wood may have been brought on to the site principally to burn, however, as there is proportionally more birch charcoal than wood, and the tar content of the species means it will burn well. The Lochan nan Cat pollen diagram (Donner 1962) shows *Betula* to have been high in the region at the time of Oakbank habitation. The differential between the levels of *Betula* wood and charcoal may reflect the preferential use of *Alnus* wood for purposes other than combustion.

Quercus sp charcoal is present, in the form of small, angular fragments. This is characteristic of oak, which shatters easily when well carbonised, such that identification often involves annoyingly small pieces. This may account for its diminutive presence in the 2 litre block samples taken.

Occasional tiny fragments of *Ulmus* charcoal have been found in the area of C6, the theoretical earliest part of the site. Elm has the same burn characteristics as oak. The pollen diagram of Oakbank done by Scaife (Clapham & Scaife 1988) shows a slight rise in elm pollen at its lowermost levels which may be contemporary with the small Bronze Age elm rise shown by Donner (1962). Levels of *Ulmus* pollen in the Killin diagram done by Tipping *et al.* (1993) were sufficiently high to suggest local growth in pre-history. These results together confirm that there was elm wood accessible to the crannog inhabitants, at least in the early stages of their occupation of the site This is reflected in the causeway piles located in 1995 (Dixon, pers. comm.) and 1982 (Dixon 1982).

Sorbus (rowan or whitebeam, not differentiable) charcoal is interesting as it only appears rarely in the fossil record. Two bowls have been recorded from the Iron Age souterrain at Fouhlin, Sutherland, identified by Camilla Dickson (Morrison unpubl.) but the species is not sited in the Coles *et al.* (1978) overview of archaeological artefacts. The species is seldom locally abundant, however, and may be under-represented as a result. Trace amounts of *Sorbus* type pollen found by Scaife (Clapham & Scaife 1988) on the site could imply low local levels of *Sorbus*. No pollen is described in the regional picture from the Lochan nan Cat core by Donner (1962), but it is recognised at low levels from the Killin axe factory (Tipping *et al.* 1993). In early history and more recent times there have been many rural traditions surrounding the rowan's supposed ability to ward off witches and evil spirits. It is the wood which is deemed to have the protective powers (Mabey 1996), with traditions involving the hanging of boughs over the doors of byres and cream stirring rods of *Sorbus* wood, both being attempts to stop the milk from souring. Cutting down rowan trees, especially those near houses, is still taboo in many parts of Scotland, particularly in the Highlands and other rural communities. A far more likely alternative of course is the edibility of the berries, which can be made into jellies or ground and dried into cakes in the same manner as *Crataegus*, for storage over winter. Occasional *Sorbus* charcoal has been found in area C6 which may reflect differential availability or lack of sufficient samples from other areas to disclose scant fragments. Nothing more can be determined from such low levels of material.

Metal-working slag and scant carbonised *Hordeum vulgare* caryopses have been discussed, but other non-wood charcoal was found in area 94B4S8. One fragment 20 x 10 x 6mm long is composed of burnt straw with adherent amorphous, shiny black material covered with small rounded vesicles of a frothy nature. Camilla Dickson (pers. comm.) has observed that such vesicles result from the burning of various foodstuffs such as honey and animal products including meat and cheese. They are also found in the burnt faeces of young, entirely milk-fed animals, including babies. The vesicles seem to arise from fatty material becoming viscous and boiling prior to carbonisation. The charcoal fragment found was in context with 7 pieces of carbonised amorphous dung, 10-30 x 15-25mm long, total weight 0.5g. These compared well to reference cow dung material and included some small recognisable Poaceae epidermis fragments, with sinuous cell margins and silica bodies. It is suggested that the burnt straw fragment may be from burnt animal pen material including young milk fed animal faeces, possibly a calf.

6.3. Wood Species Conclusions

The varying proportions of the wood species present in samples from Oakbank gives an insight into the type of woodland near the crannog. Alder formed a substantial portion of the immediate forest cover, which is attested to by the pollen record. (Donner 1962, Tipping *et al.* 1993). It possibly took over from oak as the most valuable tree for utilisation following the local removal of numbers of the slow-growing oaks during early crannog and causeway construction. The ability of alder to thrive in extremely wet places including loch margins means the species would always have been readily available and accessible.

The change from the use of oak and one (possibly chance) elm on the causeway (Skinner 1984) to mainly alder for the dwelling is quite marked, and must be deemed significant. Elm and ash maintained a low presence in the area growing on drier areas of base rich soil. The scarce remains of Pine suggest a relative base richness thereby ensuring good crops in the short term. Hazel and birch were present at the margins of the woodland and were plentiful (See Donner 1962, Tipping *et al.* 1993). Hazel may have been managed after an initial period. The importance of this species as a source of food is well known, and its requirement for wattle manufacture means that the species would have been very valuable to the crannog dwellers. Before the advent of the grey squirrel, hazel nuts in open woodland were so plentiful that a man could gather them at a rate of 7-8 nuts a minute (Rackham 1980). In modern times a ripe nut is an extremely rare sight. As hazel requires light and space to flower and fruit (Rackham 1980), being wind pollinated, it is likely that management of hazel also entailed the thinning down of encroaching major trees. Forest clearance in the immediate vicinity to the new crannog would leave good arable land for cultivation, enriched by leaf litter. Minor elements of the surrounding woodland included willow, pine and fruit wood species. These trees have different habitat requirements and imply gathering for specific purposes, as well as an understanding of differential wood qualities.

Sample/ species	*Alnus*	*Betula*	*Corylus*	*Quercus*	*Sorbus*	*Ulmus*
81A3S4	1		1			
87C6S1		4	2	5 (+1 *cf*)		4 (+1 *cf*)
87C6S5	1		2		1	
90A2S1/2			1			
90A2S3			1			
90E2S5	4	1	1			
91C2S7	3					
94A2S5	1		1	2		
94B4S8		3	2	2		
94C6S1	1		1 (+1 *cf*)			1
94C6S2	3	2	2	1	1	
94C6S4	2	1	3			
94C6S9		1				
94D2S7	2					

Table 6.2. Number and species of charcoal fragments in Oakbank samples

Sample	weight (g) analysed	total weight of charcoal (g)
81A3S4	0.15	0.45
87C6S1	1.83	3.23
87C6S5	0.7	1.35
90A2S1/2	0.2	0.2
90A2S3	0.1	0.2
90E2S5	4.6	7.6
91C2S7	2.5	2.5
94A2S5	2.2	2.2
94B4S8	1.15	4.8
94C6S1	0.3	1.2
94C6S2	1.2	2.7
94C6S4	1.0	3.35
94C6S9	0.1	0.25
94D2S7	0.1	0.2

Table 6.3. Weight in grams of charcoal fragments identified from each sample.

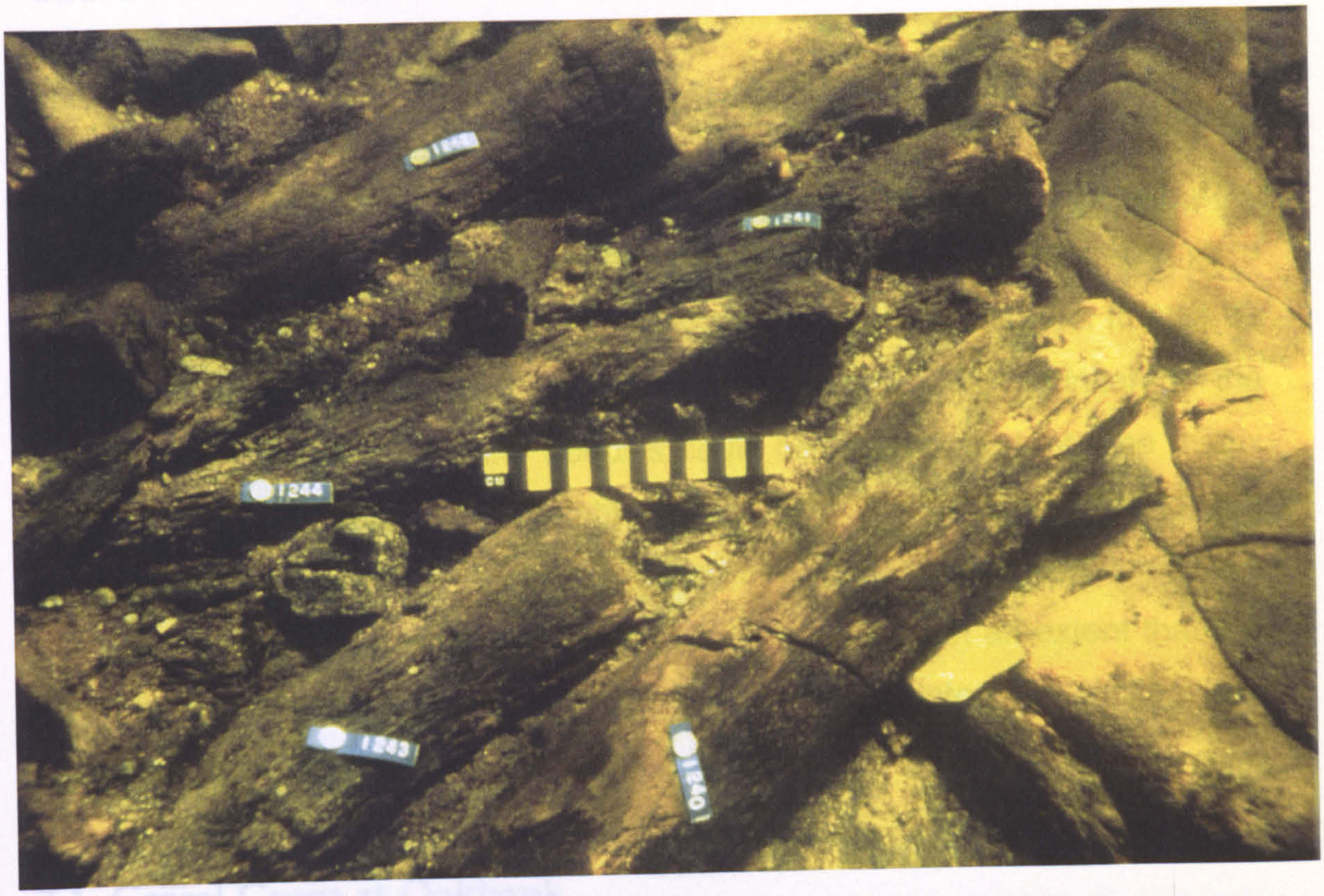


Figure 6.2. Newly exposed piles on Oakbank crannog (photo B. Andrian)

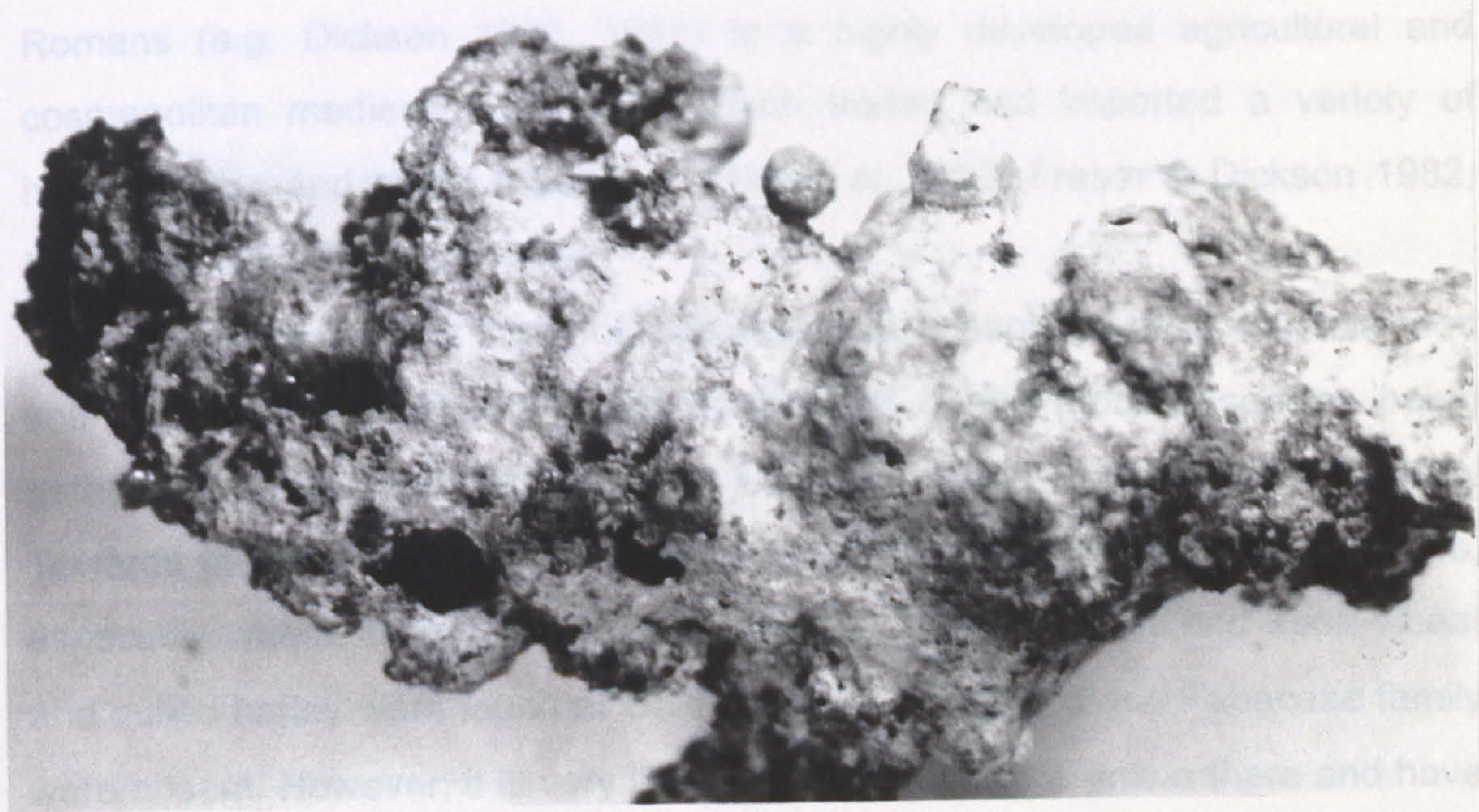


Figure 6.3. Metal-working slag drips

CHAPTER 7: THE UTILISATION OF PLANTS (OTHER THAN WOOD)

Wild and crop plant species found in the macro-fossil assemblage at Oakbank have been assigned categories indicating their potential uses on the site. This information is based on the locations and associations in which they were found. The overlap in many of these classifications is acknowledged. It must be stressed that no absolute category of human usage applies definitely to the uncultivated plants in all cases. Species could be incorporated into the matrix for a number of reasons which might apply variously at particular locations in the crannog, or different layers in its stratigraphy. Nevertheless certain species have consistently recurred in particular associations to such an extent that it is possible to assign reasons for their incorporation into the matrix, and consequently their past uses.

7.1. Cereal Crops at Oakbank

7.1.1. Cereals in the Archaeological Record

Greig's (1991) overview of agricultural practices in ancient Britain highlights the slow progression from a mainly hunter-gatherer existence in the early Neolithic through the structured local cultivation and importation systems applied by the Romans (e.g. Dickson 1989, 1991) to a highly developed agricultural and cosmopolitan medieval community which traded and imported a variety of herbs, spices and exotic foods (e.g. Hall *et al.* 1983, Fraser & Dickson 1982, Robinson 1987, Dickson 1996).

From the earliest times cereals have been identified as a valuable food source, with evidence of the wild progenitors of our modern species being gathered by the Mesolithic peoples of the Near East (Zohary & Hopf 1993). Towards the Iron Age there is an increase in the diversification of field crops, especially wheat, barley and legumes (Jones 1988). Emmer and spelt wheat and hulled barley were found at Oakbank, but members of the Fabaceae family were absent. However, it is very likely that legumes were grown there and have just not preserved, since faeces were not discovered and the carbonised assemblage was very small. Legume seeds are rarely found in the fossil record unless carbonised.

Wheat species have been separated until fairly recently by morphological characteristics, but now the ancestry of the modern cereals has been identified using genetic determination techniques (Zohary & Hopf 1993), such that the numbers of identifiable species (*sensu strictu*) is reduced from more than twelve to four. These four vary in their ploidy level, with one diploid, two tetraploid (of differing genomes, and therefore divergent ancestry) and one hexaploid species being identified. The extremely complicated taxonomy of the genus *Triticum* is not a matter for discussion here, however, except where its relevance to the evolution of agriculture has bearing on the situation at Oakbank crannog. An indication of the most current terminology reliant on genetic differences for the species relevant to this project is given below (after Zohary & Hopf 1993).

T. monococcum 2X (diploid 2n=14) einkorn.

T. turgidum 4X (tetraploid 2n=28) includes emmer (*T. turgidum* ssp *dicoccum*)

T. timopheevi 4X (tetraploid 2n=28), with different genome to above)

T. aestivum 6X (hexaploid 2n=42), includes spelt (*T. aestivum* ssp *spelta*), club wheat (*T. aestivum* ssp *compactum*) and bread wheat *T. aestivum s.s.*

This highlights the fact that the two wheats found at Oakbank, namely emmer and spelt, have different genetic origins and ploidy levels, and that spelt is more similar to bread wheat than it is to emmer. Nevertheless, for ease of comprehension in text and tables in this project the older terminology will still be used, after Renfrew (1973). This makes emmer *T. dicoccum* and spelt *T. spelta.*

Genetic advances have proved that the hexaploid wheats have evolved under cultivation from tetraploid progenitors, and have no wild ancestry (Zohary & Hopf 1993). The far later introduction of spelt compared to other glume wheats into the archaeological record is attributable to the fact that it evolved under cultivation of primitive tetraploid forms. This is discussed by Renfrew (1973), and is borne out by the fossil record for Europe and Asia as a whole, where emmer was the primary wheat crop throughout the Neolithic and up to the early Bronze Age (e.g. Greig 1991, Hopf 1991, Wasilikowa 1991, Zohary & Hopf 1993). It was gradually replaced by spelt, but still remains as a relict in parts of Europe and South-west Asia, especially Iran, and India (Zohary & Hopf 1993).

Both hulled and naked forms are known and recognised amongst the tetra- and hexaploid wheats, with the hulled forms being more primitive. Einkorn and emmer still retain the primitive wild dissemination method associated with a brittle rachis which retains the internode from the next lowest spikelet; a release mechanism designed to secure a hold on the soil for the spikelet. Possession of a non-brittle rachis, which is achieved by the free-threshing bread wheats, and to a lesser degree by the hulled hexaploid types such as spelt is an important evolutionary advancement towards cultivation. Spelt retains two points of weakness giving four possible breakage patterns (Zohary & Hopf 1993) which has relevance for the distinguishing between the spikelet bases of emmer and spelt. This characteristic and others outlined in chapter 3 have shown that spelt wheat was as abundant as emmer in the cereal crop assemblages at Oakbank crannog.

Both emmer and spelt yield high protein flour with good working properties, but require a longer ripening period than barley, and must be autumn sown to achieve a good crop. However, spelt will grow on heavier soils and is more resistant to cold, wind, and diseases than emmer, and may yield better in northern areas such as Loch Tay. Barley matures early and can be spring sown, usually producing a reliable crop with less dependence on weather than wheats. It is clear that the Oakbank inhabitants could spread their labour by planting emmer and spelt in the autumn if conditions were suitable, and barley in the spring. This would have meant that at least one, and possibly more of the crops should produce a yield. This method of agriculture reduces the reliance on good weather for planting in autumn, and has particular relevance for Scotland. If conditions were too bad to plant in the latter end of the year, planting spring sown crops would avoid starvation.

The large scale cultivation of wheat and reliance on it as a staple cereal is dependent on climate (Boyd 1988) and the Central Highlands of Scotland have never been depended on for warm dry conditions! Spelt was a popular staple cereal in southern Britain in the Iron Age until it was overtaken by bread wheat (Jones 1981), but as mentioned previously wheat cannot be relied upon in Scotland.

Barley is very tolerant of a wide range of climatic conditions (Renfrew 1973, Jones 1981), and is consequently more suited to the cool, wet Scottish weather. It withstands some waterlogging, poorer soils, and a degree of salinity (Zohary & Hopf 1993). Consequently it is not surprising that it has always been the staple crop in mainland Scotland (e.g. Greig 1991, Robinson 1987). Barley is the founder crop of Old World Neolithic food production and has been a universal companion to wheat, although regarded as inferior to it nutritionally (Zohary & Hopf 1993). It has also been valued since antiquity for its fermentation properties as beer, and is the most popular food supplement for domestic animals (Zohary & Hopf 1993), a practice which persists to this day. The benefits of barley are in its ability to be spring sown and early maturity (Renfrew 1973), thus guaranteeing a relatively good crop independent of the autumn weather. Many types of barley exist throughout the world which tolerate such a range of ecological conditions between them that the value of this crop is extremely high, especially to communities living in the more extreme ecological conditions, whether with respect to cold, heat, soil moisture or altitude (Renfrew 1973).

A primitive form of two-rowed barley was first collected from the wild like the first wheats, 17-18 000 years bc, eventually becoming a principal crop in the Near East in the Neolithic beside it (Zohary & Hopf 1993). The cultivation of primitive two-row types (*Hordeum vulgare* ssp *distichum*) was very quickly replaced by the more economically viable six-row barley (*H. vulgare ssp* vulgare) through domestication. Both naked and hulled forms exist, and the naked type is often known as *H. vulgare ssp* vulgare var. *nudum*. All cultivated varieties require threshing due to a non-brittle rachis (Zohary & Hopf 1993).

The majority of British domesticated barley grown since the Bronze Age is hulled, having replaced the naked variety which was dominant in the Neolithic (van der Veen 1992). Naked barley was still dominant in Scotland in the Bronze

Age (Greig 1991). The change over to hulled barley may at first seem surprising, since the fused glumes of hulled barley require pearling to remove them for human consumption. However, this is thought to have been partly due to both the climatic shift towards increasing wetness and changes in farming practices, including types of cereals cultivated and animal husbandry (Jones 1981, van der Veen 1992). The spikelet structure of naked barley is more open than hulled types, such that in wet conditions the naked forms retain more water and are subsequently more prone to premature sprouting or fungal attack than hulled types (van der Veen 1992).

At Oakbank the lack of carbonised grain means it is not possible to quantify the amount of naked barley (if any) present on the site. There is at least some hulled barley present, but much is indeterminate with respect to this.

The beginning of soil fertilisation and crop rotation in some parts in the early Iron Age in response to the soil becoming exhausted (Jones 1981) meant that better yields of the high protein wheat crops could be grown for human consumption in suitable areas, leaving barley for malting and animal fodder where the glumes are not of any relevance. The shift towards wheat cultivation for human consumption over barley was not ubiquitous, however, and as mentioned above, barley was still part of the staple diet in large areas of mainland Scotland where climatic conditions do not favour high yields of wheat. This persisted until fairly recently. Here the move towards hulled barley is understandable, guaranteeing some semblance of a crop despite poor weather detrimentally affecting the less tolerant wheat crop and causing famine. Obviously this is a complicated issue which is different for every site location, and does not consider the effects of trade on this balance of species.

Oats are a valuable crop on marginal land, and *Avena strigosa* (bristle oat) has been grown up to the present day in the Northern and Western Isles, where its ability to produce a crop in water-logged marginal soils is reported by Hinton (1991). However, the incidence of oats at Oakbank is so minor as to imply that the species was not grown as a crop in its own right. The preservation of the caryopses was not adequate to allow specific identification, but the wild oat *Avena fatua* is suspected. It is a troublesome weed of cereal crops which was gathered by American native people at the turn of this century as 'bread corn' (Hedrick 1972), and may have been an acceptable weed in the Bronze/Iron Ages. The same may have held true for *Bromus* spp, and indeed *B. hordeaceus* was frequent in Oakbank cereal assemblages. Jones (1988) suggests that there would have been far less distinction made between weeds and crop in antiquity.

7.1.2. Cereal Crop Assemblages at Oakbank Crannog

There is no carbonised record of wheat and only a very few carbonised barley grains at Oakbank, which reflects the uncertainty about the location of the domestic cooking hearth. All wheat evidence comes from the waterlogged processing waste and poorly preserved caryopses. Nevertheless this does demonstrate the availability for consumption of emmer and spelt, both of which are better stored in the spikelet in wet climates to minimise pest attack prior to small scale processing on an almost daily basis (Hillman 1984). Wheat remains found in household deposits at Oakbank were never frequent compared to barley (see table 3.2.), suggesting that less might have been available to waste, which may also reflect on the increased value placed on wheat relative to the more abundant barley.

The range and numbers of cereal remains and their crop assemblages recovered at Oakbank suggest three different household contexts within the dwelling. The first of these is the daily piecemeal processing of spikelets for consumption. Occupation deposits from areas A2 and A3 (see figure 1.3.) revealed assemblages of arable weeds and cereals in the form of caryopses and chaff in sufficient numbers to suggest that the daily processing of stored crops occurred here. Hillman's intensive studies of crop processing methods of primitive communities have recognised some thirty operations involved in the growing of a crop and its conversion to food (Hillman 1984). The flow diagrams he devised are widely recognised and been used in many studies to identify the processing stages characterised by the macrofossil assemblages.

At Oakbank crannog the crop processing stages represented in areas A2 and A3 are a combination of two processes. The first of these is the final sieving (stages 12 and 13 in Hillman's 1984 chart, p5), where tail grain, small weed seeds and heavy chaff fragments in the form of glume bases and rachis segments are removed to the cleanings store for either animal fodder or famine food for humans. The crop components in the gut of both Tollund and Grauballe Man led Helbaek to suggest these men had consumed cleanings from this stage of processing (Helbaek 1950 & 1958). The gut of Lindow Man showed similar remains, but Holden (1995) thought this could just as easily have been an acceptable level of contamination for every day food, rather than starvation or prisoner fare. Holden found rather higher values of wheat bran than were present in A2 assemblages at Oakbank, however, and it is likely that the situation here is not the same as the one he suggests.

The second stage of crop processing indicated by the A2 crop assemblages is that which follows the final sieving to remove the fine cleanings, namely the hand sorting of prime grains from weeds of the same size which were retained in the sieve during the previous step. This would account for the low incidence of wheat caryopses but more frequent chaff in the macrofossil assemblage, since hand sorting of such a valuable resource would have been done thoroughly. As a lot of the barley caryopses found were small tail grains, it is likely that many were removed with the fine cleanings sieving too. Barley caryopses were more frequent than their chaff remains here, and throughout the site as a whole. It is recognised that barley has a tough rachis, however, and much of this may have broken into larger pieces that were removed earlier with coarse cleanings, including the larger straw fragments. The fine cleanings stage is the one most frequently recognised in British archaeological deposits (Hillman 1984) which may be directly due to the damp climatic conditions and the requirement for daily processing.

Weed seeds in the cereal crop assemblages at Oakbank were consistently varied and numerous. As mentioned above, Jones (1988) stresses that there would have been less distinction made between crop and waste in antiquity, especially in times of want. He further observes that the weed flora would have been far more diverse then than it is now, due to both soil exhaustion and poor tillage methods. A basic wooden ard has been recovered from Oakbank crannog (Dixon 1984b). This means that the soil would have been only lightly tilled then, and in this situation perennial weeds can survive cultivation too (Hillman 1981).

Care has to be taken in attempting to designate status to a macrofossil assemblage when it contains perennials which can grow in both arable and waste/grassland situations, since these species could have come from either situation. At Oakbank both mixed hay and cereal crop assemblages were often together, and it must be recognised that there could have been some degree of overlap with respect to species here, since the soil was tilled by ard. Nevertheless some seeds were frequently present in assemblages containing crop waste, and are thought to represent arable weeds rather than hay. These include *Avena* sp, *Brassica rapa* ssp *campestris, Bromus hordeaceus, Cerastium glomeratum, Chenopodium album, Fallopia convolvulus, Galeopsis* subg. *Galeopsis, Galium aparine, Lapsana communis, Persicaria lapathifolia, P. maculosa, Polygonum arenastrum, P. aviculare, Rumex* spp, *Sisymbrium officinale, Sonchus asper*, *Spergula arvensis* and *Stellaria media.* Many of these species recur time and again in archaeological crop assemblages, and have nutritional value such that they were probably accepted and kept to boost a failed crop (Jones 1988). Other weed species are more variable with respect to habitat, and could have come from either or both situations. This applies mainly to some species of *Carex, Juncus, Ranunculus* and *Rumex* which could have grown in the wetter areas of arable land as well as waste/grassland. Specific habitats are discussed more fully in the environmental section.

The heights of the weeds present in an arable crop can tell something about the methods of harvesting used. The weeds at Oakbank were of various heights, but enough are of small enough stature to suggest reaping low on the culm (Hillman 1984). Their abundance further precludes the possibility of harvesting the ears alone, since this would produce a crop with very few weeds (Jones 1988). The identification of harvesting methods also has implications for other household activities, suggesting that straw was not the principal thatching component. Crops harvested in this manner require to be threshed, and this would break the straw.

Other crops were also processed in area A2, which was a place where much activity occurred. The seeds of gathered wild fruits and nuts were found here, and capsule valves and seeds of *Linum usitatissimum* remain from the processing of this crop. Jones (1981) argues that low numbers of remains of crops other than the principal one could result from crop rotation and the persistence of occasional plants as weeds. However, flax does not compete well with arable weeds, and so this would only occur for one or two seasons. As high numbers of flax remains were sometimes found at Oakbank, and given the numbers and diversity of the weed flora associated with the cereal crops, it is more likely that flax remains here represent their independent and tended cultivation, although this might only have been on a minor scale.

The second way in which cereal assemblages are found at Oakbank is from within floor deposits in context with evidence of mixed hay and ovicaprid dung, suggestive of the remains of fodder. This situation was found mainly in areas B4, C2 and C6. Robinson (1987) also observed this combination of assemblages in medieval Perth. Species representative of the mixed hay fodder are discussed in greater depth in the section dealing with animal husbandry. These assemblages showed an admixture of this hay fodder and cereal processing waste, which was a combination of the fine cleanings collected during the sieving at stages 12 and 13, to which had been added the larger and heavier chaff fragments removed earlier in the process (Hillman 1984). Hillman further observes that fine cleanings destined for human consumption would not have had the heavy chaff added to them.

The third household context represented by Oakbank cereal assemblages, including their weeds, is that of a general occupation floor. Low levels of arable indicators were repeatedly observed in samples from areas other than those mentioned above, but not in high enough numbers to signify anything other than general occupation. This adds further emphasis to the speculation that areas within the dwelling were used for different functions, including food processing, sleeping, animal care and general living.

7.1.3. Relevance of the Oakbank Cereal Assemblage to Archaeology

Clapham & Scaife (1988) indicated the presence of spelt at Oakbank, but without the benefit of extensive sampling they were unable to ascertain the degree of usage of the wheat. Spelt has been found in very small quantities in Eastern and Central European sites since the Neolithic (Zohary & Hopf 1993), but the British macro-fossil record has not gone further back than the Bronze Age (Greig 1991). It has been found on Bronze Age sites in England, (e.g. Black Patch, Sussex (Hinton 1982) and Runneymede, Surrey (Greig 1990), but is not known in the Scottish fossil record before the Roman invasion (Dickson 1989).

The relevance of spelt as a crop with at least equal value to emmer at Oakbank indicates that the utilisation of the species was known and appreciated in the Central Highlands of Scotland much earlier than would have been expected. It is not possible to say whether the wheat was traded or locally grown, as highlighted by van der Veen (1991), as there was no indication in the macrofossil assemblage of alien weeds or those with a southerly distribution. Biochemical analysis of spelt from Roman sites such as Bearsden implies importation of 'southern spelt' (Francis McLaren, pers comm to Camilla Dickson). These investigations cannot be attempted at Oakbank, however, but it seems likely that emmer and spelt would have been grown on a small scale on land which was well drained and sheltered in the vicinity to the crannog, with barley in other areas. The relative proportions of the crops grown may have varied annually in response to the weather at the time.

Although there is no direct evidence to prove or disprove this, it is possible that the cultivation of wheat may have been in association with a loch-side community encompassing the adjacent Fearnan crannog and other contemporary sites on Loch Tay, rather than self contained subsistence units. This would have maximised the availability of suitable land conditions to the community for valuable crops, and could be another reason why spelt and emmer grains were infrequent in the assemblages. As mentioned previously, great care would have been taken in the processing of a valuable resource, especially if it was not abundant. Further work on the remaining crannogs at the head of Loch Tay may provide information about the possibility of a community there.

In summary, the cereal assemblage at Oakbank indicates that six-row barley, emmer and spelt wheat were grown for human consumption. No human faecal evidence has been recovered, but processing evidence and floor debris mixed with animal dung indicates that barley tail grain mixed with a small amount of prime grain and wheat chaff was fed as a supplement to fodder to at least goats or sheep, and possibly other domestic animals. This is likely to have been during the winter months as was the case in medieval Perth (Robinson 1987), or for other short duration visits such as milking.

Both emmer and spelt wheat chaff remains are present in low concentrations in floor and byre assemblages, signifying fodder. Very few caryopses amongst this reflects the value put on wheat at this time. Almost daily processing on site is indicated by the presence of glume and spikelet bases, and following the ethnographic parallels set out by Hillman (1984). Spelt wheat is shown to have had equal value to emmer, highlighting the earlier than suspected introduction of the wheat to Scotland. This implies established trade links at a much earlier date than would be suspected, and is thought to be the same way through which *Papaver somniferum* became incorporated on to the site. The incidence of oats at Oakbank is too low to reflect anything other than the chance incorporation of wild crop contaminants.

7.2. Gathered wild food

The high incidence of seeds, fruits and nuts of wild potential food species in the macro-fossil record at Oakbank highlights the importance of gathered food as a supplement to cultivated crops to the Oakbank community. Vegetables as such are a medieval phenomenon (Harvey 1984), but the practice of cooking potherbs is an ancient one. Many wild plants produce nutritive green food, which although perhaps not to our modern taste, are at least edible. Some are very much so. Potherbs would have been added to the staple cereal in a broth with fish or meat, flavoured to taste.

The late summer and early autumn produce a plentiful harvest of soft fruits and high calorie nuts in open woodland areas such as those present around the crannog. Much of the softest fruit, including strawberries, raspberries and brambles, would have been eaten fresh soon after collection, but others would have been stored as an important source of calories for the winter months ahead.

7.2.1. *Corylus avellana* (Hazel)

Within this category the nuts of *Corylus avellana* (hazel) are notable, with a presence in eleven out of seventeen samples of matrix deposits throughout the site. All these samples represent occupation deposits, and low to moderate levels of broken nut shells confirm the general availability and use of the species. The larger manual collections from within 90A1/2GEN emphasise the role hazel nuts played in the economy of the site.

Hazel nuts have been inextricably linked with human occupation sites in Britain and the continent since the earliest times (e.g. Zohary & Hopf 1993: Kroll 1994). The benefits of hazel nut consumption are in their high nutritive value coupled with their storage ability and value as a 'snack' item, forming a welcome supplement to the staple cereal diet, especially in poorer yield years. Nuts can also be roasted and ground into a nutritious and palatable flour (Howes 1948, Wilson 1972). Their ability to be stored for months (Hedrick 1972) means that a satisfactory collection in the autumn would provide a guaranteed, high calorie supplement to cereals in winter and spring until other food sources became available. Before the grey squirrel was introduced into this country, wild hazel nuts were a plentiful source of wild food.

Hazel bushes require light in the form of open woodland or clearance areas to flower (e.g. Schwankl 1957, Dimbleby 1967). Consequently the margins of areas of woodland cleared for constructional timber and agriculture would produce good crops. Hazel was also much used for wattle at Oakbank, however. Coppicing of hazel branches limits nut production in the short term and there is possible evidence of coppicing in much of the large quantity of hazel round wood found at Oakbank. It is possible that the utilisation of hazel in the vicinity to Oakbank may been subject to some sort of rotation of use, alternating between nut and rod production.

7.2.2. *Prunus spinosa* (Sloe) *and Prunus padus* (Bird Cherry)

Both bird cherry and more frequently sloe fruitstones were found in various locations at Oakbank, mixed into general flooring debris, and present in quantities manually recovered during the excavation. Flowering, and consequently fruiting, is increased in open woodland areas in the same manner as hazel (Dimbleby 1967), and the species may have fruited together in cleared wood margins. Sloes are frequently recovered from historic and pre-historic occupation sites (e.g. Hall 1986, Moffett 1992, Dickson 1994), and are particularly common from Anglo-Saxon/Anglo-Scandinavian cess pits, although both sloes and bird cherries are renowned for their extremely acidic flavour. Wilson (1972) advises that the astringency of sloes as a medicinal aid for tonsil, teeth and gum complaints was acknowledged as far back as Pliny. Bird cherries contain cyanide, however, (Lang 1987), and are not thought likely to have been eaten intentionally, unless for some medicinal concoction. The species is not recovered from archaeological latrine fills in anything like the frequency that other *Prunus* species are, where it may have had more medicinal implications.

The acidic flavour of sloes is reduced greatly by heating and drying (Wiltshire 1992), which improves the taste and reduces the toxicity of the acid astringent fruits rendering them more edible, either dried or rehydrated. It must be stressed that our modern tastes are far more orientated towards sweet things than past communities. *Prunus spinosa* fruitstones were isolated from the closely similar *Prunus insititia* (bullace) on the basis of their smaller size, rounded shape, and lack of an obvious point, (Moffett 1992).

Heat drying improves the flavour of fruit such as sloes, but also inhibits microbial growth, such that they can be kept for a considerable time (Wiltshire 1992). This would have been a useful way of maintaining a good source of food and vitamins for the periods following the late summer bounty. Wiltshire further suggests that processing will increase the availability of sugars for fermentation and reduce the tannin activity, and that alcoholic drinks or fruit steeped in alcohol would have been very palatable. The practice of making 'sloe gin' is popular today. Hall (1986) observes that sloes steeped in honey for several months produce a mead-like syrup which is very pleasant to taste, so perhaps the thought of sloe fruits as food on Oakbank crannog is not so distasteful as first thought.

There was no indication of *Prunus avium* (wild cherry) in the Oakbank assemblage. If this species had been present in the area it would most certainly have been eaten. It may be that the absence of wild cherry stones in the matrix is more a reflection on the ancient habit of swallowing the fruit whole, complete with fruitstone, than spitting this last out. No human excrement was found at Oakbank, but a faecal concretion containing wild cherry fruitstones from the Pictish site at Dundern (Dickson & Brough 1989) attests to this possibility. Fragments of *Prunus cf spinosa* from area A2 in the crannog matrix may be from crushed stones consumed with the fruit. The composition of the organic detritus and location of the grid square near the entrance causeway make the suggestion of faeces more plausible. However, this cannot be proven conclusively without recourse to coprosterol analysis.

7.2.3. *Rubus chamaemorus* (Cloudberry)

A total of seven seeds of *Rubus chamaemorus* (cloudberry) were found at Oakbank in contexts from areas A2 and C6 (see figures 3.14.and 3.15.). Cloudberry is a low-growing montane species confined to deep peat in altitudes above 700m in the central Highlands of Scotland (Taylor 1971). It is insect pollinated and dioecious, attaining 5-20 years before flowering (Taylor 1971) and is traditionally gathered in Scandinavia where it grows abundantly. The fruits have been reliably gathered in Norway since the Early Medieval (Griffin 1994) and are extremely palatable. However the success of the species relies mainly on vegetative propagation such that an area of plants covering several square metres may have derived from a single origin (Taylor 1971). This has implications for sexual reproduction and subsequent berry production. Individual drupelets within the berry are frequently sterile as a testament to the species' reliance on vegetative reproductive means (Taylor 1971).

Although berries are frequently seen in Scandinavia, modern cloudberry plants fruit very rarely in the Breadalbane region of Scotland, to the extent where six berries seen over the whole Ben Lawers area is locally deemed a very good year (Lawers nature warden, pers comm 1996). Mabey (1996) suggests that the majority of the Scottish cloudberry population is male, which would certainly account for its low fruiting potential in general in this country.

The ripe fruit, where available, is consumed by moorland birds including Ptarmigan and grouse, but initial flowering coincides with red deer and sheep lactation and the high protein flowers are frequently grazed before they are able to set fruit (Taylor 1971). This may partly account for the species' low fruiting in female populations in the modern records. However present day red deer are only a moorland animal by necessity, as their preferred forest habitat has been denuded, (Rackham 1990). In pre-history this would not be so relevant. Predation by the voracious wolf population would have kept the deer numbers in check, and presumably the woods would offer better protection and camouflage for fawns. The sheep population was also much reduced in pre-history compared to modern times. It is suggested that although the fruit may never have been frequent, sufficient berries would have been available for the Late Bronze/Early Iron Age crannog community to purposely gather as a treat when the fruit was encountered.

Human involvement with cloudberries throughout the ages is highly probable, but the species is incredibly rare in fossil records. The discovery at Oakbank represents the earliest find in British pre-history, and only the third such in the entire British fossil record for the species. Other finds are a late Iron age settlement in Upper Teesdale (van Der Veen 1988) and medieval Perth (Fraser & Dickson 1992), where one half 'pip' was probably chance incorporation in peat. The seven cloudberry seeds found at Oakbank crannog were in two locations, such that more than one collection incident is shown. In this site the chance of accidental incorporation with peat is very low, as the distance required to travel to cut peat likely to have had cloudberry plants growing on it is too great to be economically sensible. There are areas of peat suitable in terms of proximity and composition for household consumption far nearer to the crannog than those which support cloudberries.

Figure 5.1. shows a map of the Ben Lawers area of Breadalbane with modern cloudberry locations marked. There is no reason to expect that the situation would have been any different in the Late Bronze/Early Iron age, given the species' habitat requirements, especially topography. Two seeds have been sent for AMS dating to provide an accurate date marker for this rare species in Scottish pre-history. It is suggested that its absence on suitable sites of later dates implies rarity in general rather than lack of human interest in the fruit.

The condition of the seeds is excellent, with surface pattern intact. They are large (4.0-4.2mm x 2.9mm) and would be highly likely to be broken or show signs of abrasion if they had passed through a bird's gizzard. A similar situation would result if they had been masticated as thoroughly as large herbivores require to do to break down cellulose plant walls. Goat/sheep droppings from the house site occasionally show other wild Rosaceae family seeds such as *Rubus idaeus* (raspberry) which are much smaller but still are only fragmentary remains. Robinson & Rasmussen (1989) have demonstrated the degree to which goats and sheep masticate cereals also. Accidental deposition of cloudberry seeds from within the crop of a killed moorland bird is also thought to be improbable, and as the seeds were not found in context with heather shoots, the staple diet of these birds, and were intact.

The context the seeds were found in is from within sealed house floor deposits. Detritus above and below is of a similar context. Deposition by flying birds is eliminated by this sealed matrix condition and the absence of roofing material in the immediate vicinity. It is questionable whether the types of birds likely to eat cloudberries, such as red grouse, black cock, and ptarmigan, would be found in the vicinity of this low altitude site. The converse is true for other bird species from within the crannog area habitat. Ingestion and subsequent defecation of the seeds by a dog is possible, but the seeds were not found in a coprolite context of any form. This would have preserved given other similar examples.

Other possible means of accidental incorporation can be discounted. As mentioned previously, the cutting of heather would be more sensible at lower altitudes. One well established cloudberry plant can cover several square metres (Taylor 1971), competing well for space with the heather, such that chance incorporation would not be likely in any case. The berries stand well above the leaves and would only become entangled if the plants were severely overgrown. Similarly peat-cutting is inappropriate when the surrounding forest supplies more immediately accessible fuel, as demonstrated in the fossil record for the site. Also, the berries within which the seeds are contained are smoothly rounded and not able to adhere to clothing or fur. *Rubus chamaemorus* is unlike many other Rosaceae members in being devoid of thorns of any kind.

The discovery of cloudberries on a loch site some hours walk from their nearest habitat highlights the utilisation of land at great distance from the homestead by the late Bronze-early Iron Age crannog people. Morrison (1985) signifies crannog and dun status as varying with offshore conditions, but both having good arable land immediately adjacent. This discovery emphasises the fact that this may not be the only land criterion relevant to initial decisions where to build. The Oakbank crannog people were pastoral as well as arable farmers, and utilisation of the hill land in the vicinity of the crannog is implied from remains of moorland plant species including heather on the site. Bone evidence in general is poor, but does not suggest that hunting played an important part in the diet of the crannog dwellers. Transhumance to upland grazing is more likely, as suggested from both the heathland plant remains and fodder assemblages at Oakbank. These are discussed in detail in section 7.3.

Cloudberries are highly unlikely ever to have been prolific in the central Highlands, but may have been more common in pre-history due to low grazing pressure. They do not grow in the immediate vicinity of the crannog and must have been collected intentionally, either during a special expedition, or perhaps more likely by a hunter or shepherd tending his flock. This has great implications for human behaviour at some distance and altitude from the homestead.

7.2.4. *Rubus idaeus* (Raspberry), *Rubus fruticosus s.l.* (Bramble), and *Fragaria vesca* (Wild Strawberry)

Fruits of these wild species would have been prolific in woodland clearances and waste places around the crannog site. Raspberries and brambles in particular would have been abundant, colonising any disturbed nitrogen-rich soils especially those near middens or where animals were kept. They are abundant in the fossil record as weeds of habitation sites, especially the later towns, and often following abandonment or downgrading of the site. They are not suspected in this instance to suggest abandonment above water, however, as seeds would have been prolific in layers immediately preceding phases of reconstruction, especially of brambles. Seeds found in samples examined were from matrix representing household activity and accidental loss.

Fruitstones of raspberry were more common than bramble, and few of wild strawberry were found. However, the species are all very palatable and would have been eaten if available. The relative scarcity of wild strawberries compared to raspberries is probably as a result of the direct consumption of these tiny fruits. Wild strawberries are so small it is easy to squash them, whereas the bigger berries of raspberry and bramble would be more readily transported home. Their presence on the crannog may indicate faeces, accidental loss, or disposal of fruit that has gone bad. On a water based dwelling it very unlikely that a cess pit would be found, however, so consumption through sewage would be hard to prove. Nevertheless, the utilisation of fruits of all three wild species as a summer food source is thought highly probable.

7.2.5. *Rosa cf canina* (Rose, *cf* Dog rose)

Seeds of *Rosa cf canina* were found occasionally at Oakbank. Their presence may imply collection for the vitamin C rich hips, or may have been accidental with collected wood or wild flowers. No rosewood was found by this author, but Dixon (1984b) reported its rare presence. It is probable that the seeds found do derive from collected hips, which could be dried and stored in the same manner as the fruits of *Prunus spinosa* and many other Rosaceae.

7.2.6. Potherbs: *Urtica dioica* (Nettle), *Chenopodium album* (Fat Hen), *Lapsana communis* (Nipplewort), *Sonchus asper* (Prickly Sow Thistle), *Stellaria media* (Chickweed)

The cooking of leaves and shoots of young plants as potherbs with barley and meat or fish is a practice known from the Romans and probably earlier (Dickson 1994). Many wild plants have edible parts, but without direct evidence it is impossible to confirm their use in this respect (Hall 1986). This is also true for Oakbank, without direct evidence of human effluent. However all the species mentioned above have been suggested as such in the literature, (e.g. Harvey 1984; Crackles 1986; Hall 1986) and their consumption as such is possible and likely. Barley is the most frequently found cereal at Oakbank in common with prehistoric deposits from much of mainland Scotland, and would have been the staple cereal. Pottage made from barley with other constituents would be accompanied by barley dumplings or unleavened bread or griddle cakes produced from spelt and emmer wheat. No bread wheat (*Triticum aestivum s.s.*) was found to suggest leavened bread at Oakbank.

The young leaves of nettles, fat hen and chickweed are rich in vitamin C and would provide a good source of this in the spring months. Cooked epidermis remains of potherbs are so delicate that they survive only infrequently (Dickson 1994) and consequently are prone to being under-represented in the fossil record. The robust seeds do survive, but potherbs are likely to be collected prior to the energies of the plant going into seed production, so the presence of seeds on a site is more likely to suggest collection of the plant for another reason. This may be fibres (*Urtica dioica*), crop contamination (*Chenopodium album, Lapsana communis*, *Sonchus asper* and *Stellaria media*) or accidental. However, the frequent occurrence of seed remains on the site does imply availability for use. Consequently, although it is not possible to demonstrate directly the consumption of potherbs at Oakbank, it is most probable that at least some of these very commonly occurring plant species were used for this purpose. Clapham & Scaife (1988) suggested *Chenopodium cf album* had been specifically harvested, but neither their study nor this one has proven that yet.

7.3. Evidence for Animal Husbandry and Fodder

Preserved sub-fossil faeces of domestic animals are extremely rare in the archaeological record. Many of the finds to date have originated from the Neolithic Swiss lake settlements including Robenhausen (Heer 1866), Weier (Robinson & Rasmussen 1989), Egolzwil 3 (Rasmussen 1993) and others reported by Rasmussen (1993). Elsewhere, finds include droppings from the Bronze Age Italian lake site of Fiavé (Perini 1987), and the medieval Danish shipwreck at Falster (Robinson & Aaby 1994). All are from waterlogged sites, and with the exception of the last mentioned are from ovicaprid (goat or sheep) dung. This might suggest a preference for the husbandry of these small animals on these prehistoric lake settlements, but could also be due to the discrete form of goat and sheep droppings, being small and dense enough to maintain their shape under waterlogged conditions. Bovine and pig dung is larger and more amorphous, disintegrating into floor litter more readily. Although faeces from prehistoric cattle allowed to follow natural browsing behaviour would have more shape than the perpetual loose motions their modern counterparts have due to enforced grazing, they would still be more liable to disaggregate into the litter matrix than ovicaprid droppings, by size alone.

The value of sub-fossil animal faeces in terms of the information they can yield about animal husbandry practices and the local environment has been recognised. The shape of droppings can imply their specific origin(s), in a pure or mixed assemblage. Macro and micro-botanical investigation of the remains will provide information including the diet of the beasts, where they were fed, and possibly the time of year when they were stalled. This last cannot always be inferred from pollen studies, however, as the comparative analyses of foxes with Neolithic dog faeces by Vermeeren & Kuijper (1993) demonstrates. Nevertheless the abundance of *Corylus, Betula* and *Alnus* pollen and small twigs with minimal spring growth on their outermost rings was taken to infer leafless twig foddering of goats and sheep in early spring at the Neolithic site of Egolzwil 3 (Rasmussen 1993).

The preservation of animal bone at Oakbank is poor (Dixon pers. comm.), but bones and especially teeth of sheep or goats, cows and pigs were found on the site. The droppings of sheep, goats and possibly cows have also remained to provide direct evidence of the husbandry of these animals. The separation of sheep from goat droppings is problematic and only possible when the faeces are entire and well preserved. Sheep faeces are rounded and generally larger than goat droppings, which are more elongate, with a pointed end. Photographs emphasising this distinction are shown in Rasmussen (1993). The identification of entire ovicaprid droppings from Oakbank suggests that both sheep and goats may have been kept. Goat droppings were more numerous, but not sufficiently so to state whether the animals were more abundant. This was also the case at Egolzwil 3 (Rasmussen 1993).

Large compressed mounds with small fibrous plant fragments within them and the general appearance of cow or (less likely) pig dung were also occasionally found at Oakbank. These were often in context with charred wood and might have been intended as fuel. They perhaps retained their shape and texture through being dried for this purpose prior to incorporation in the matrix. The scant occurrence of these faecal concretions and bone remains prevents further debate regarding the abundance of pigs and cattle at Oakbank crannog. Samples containing discrete droppings frequently also had faeces unrecognisable with respect to origin dispersed throughout them. These may be from any domestic animal. Human excrement is not considered here, as cereal bran fragments contained within them were larger than humans would find palatable, or milling would produce. This concurs with the situation suggested by Robinson & Rasmussen (1989).

The presence of faeces on the site means that animals were inside the dwelling, either for feeding and stalling, milking, or slaughter. Numbers of faeces and samples in which they were found are shown in results table 4.1. Where numbers were low, an absolute figure is given. The symbol '~' designates more numerous droppings, the numbers of which were not accurately noted. The relatively low presence of dung in some samples analysed is explained by the block nature of the samples taken and the possibility that in some instances animals were only housed at night or for short milking stays. Their bedding may also have been added to on a regular basis.

Insect remains in the form of eggs, beetle fragments and fly pupae were often in association with matrix representing animal litter. Some of these may be as a result of the presence of faeces, but others may correspond to other conditions. It is not the purpose of this study to investigate the invertebrate remains found during sampling, although the benefits of collaboration with an insects expert is recognised.

It was not possible to identify dung from cows and/or pigs other than tentatively and occasionally at Oakbank, but small amounts of indeterminate faecal matter within the matrix may have been of these kinds. For the purpose of this discussion, faeces referred to are primarily ovicaprid (including sheep or goat), unless otherwise mentioned.

Droppings were noticed in C2 and B4, but primarily in C6 contexts. This may suggest that at one stage this small contiguous area of the crannog site (see figure 1.3.) was primarily an animal enclosure, was cleaned more infrequently, or that animals shared the dwelling with the occupants without separation. The abundant occurrence of human habitation remains in the C6 area indicates human occupation at one stage. It may be that the animals 'inherited' this smaller dwelling after the larger house was built. Although the entire site has not yet been excavated, in samples from this study faeces were only found in areas C2 and B4 on the larger mound. This suggests they were excluded from parts of the house.

Droppings were most frequently found mixed into a particular type of organic matrix, and it became clear that this represented animal enclosure litter and fodder. Samples 94C6S4 and 94C6S9 are typical of this, with high numbers of plant species in the matrix indicative of litter and fodder. Discernible ovicaprid droppings were present in quantities here mixed with further, unidentifiable dung and copious bracken fronds and long stemmed *Juncus* species seeds and capsules suggestive of animal pen flooring material. It is unlikely that either the bracken or rushes were intended for consumption, as in their mature state neither are positively selected by domestic animals in the presence of more palatable alternatives. Martin (1955) revealed cuticle of

Juncus effusus in modern hill sheep faeces, but in low percentages compared to other species.

Analysis of the matrix surrounding the droppings in samples such as but not specifically 94C6S4 and 94C6S9 revealed fruits of the small Poaceae and other low growing grassland species. This suggests that animal fodder included hay cut close to the ground. A hay meadow is a complex and structured plant community, as distinct from a planted crop which consists only of the single crop species and its associated weed community (Greig 1984). The National Vegetation Classification distinguishes seventeen main types of mesotrophic grassland, of which five are used to make hay. These are discussed by Greig (1984), whose experiments to ascertain the relative abundance of individual species in hay crop assemblages are comparable to the ethnographic crop processing parallels of Hillman (1981, 1984). Greig observes that the species present in an assemblage will vary with both habitat and time of cutting of this semi-natural crop. Base-richness, the drainage of the area, and the time of setting seed will all have a bearing on the resultant assemblage, as well as the robustness of individual seed species and their ability to survive as fossils (Greig 1984).

The results from Oakbank crannog have shown that lowland hay is present, as characterised by the abundance of members of the Poaceae and wild grassland flowering plants, but it is acknowledged that the assemblages there are very mixed, both in terms of their stratigraphy and individual components. Consequently it is not deemed sensible to attempt to classify the hay assemblages from the various samples, since several collections may be present, taken from different locations. They may contain hay from meadows of various types along with some from what would now be termed waste areas, including track-sides, and remains of other entirely unrelated activities. This latter is characterised by the inclusion of members of the Apiaceae (Greig 1984), and these have been noted in hay assemblages at Oakbank.

Ancient hay meadows were not the species-poor grass-dominated pastures we see today, which have resulted from modern farming practice. Far more flowering plants were present in those times, and the composition of particular meadows was dependent on the nutrient status and drainage of the land. The occurrence of members of the genus *Carex* and also *Ranunculus repens* implies some hay was cut from areas including damp and wetter meadow. Tall broad-leaved species with nutritive value were also present in the matrix, including *Urtica dioica* in abundance. This may imply mixed fodder, but could also suggest the growth of nettles on the nitrogen enriched substrate following the animals' subsequent removal. There would have to be no disturbance for two seasons for the nettles to set seed, however (Greig-Smith 1948), so the species' occurrence signifies either abandonment or purposeful collection. The nettle seeds may also represent effective usage of waste from fibre manufacture.

Crop contaminant weeds were also incorporated into this litter and fodder type of matrix, including notably *Bromus hordeaceus, Cerastium fontanum/glomeratum, Chenopodium album* and *Galeopsis* subg *Galeopsis*. Sample 94C6S9 also included frequent remains of *Calluna vulgaris*, which may have been from bedding, fodder, or some other purpose such as rope production. Martin (1955) shows the selection for consumption of *Calluna vulgaris* by hill sheep. Cereal processing waste in the form of *Triticum dicoccum* and *T. spelta* spikelets and glumes and lesser amounts of *Hordeum vulgare* rachis internodes were present in more abundance in matrix samples containing animal faeces than in any other areas of the site.

The weed seeds and chaff found here are indicative of crop processing waste at the fine cleanings stage (Hillman 1981, 1984). Barley rachis internodes often remain joined together in longer pieces when threshed and in this situation would have been removed earlier with the coarse cavings (Hillman 1984). However, these cavings are fed to livestock, so they would have been expected in samples containing fodder. Consequently it is possible that their relative scarcity compared to wheat chaff even in such samples may reflect differential preservation. Poaceae culm nodes and epidermis fragments from hay and/or straw are present in matrix samples representing animal enclosure remains more frequently than elsewhere on the site, although never abundantly. A few indeterminate buds present in the matrix may be incidental, or have been incorporated into the fodder.

Interestingly, wheat caryopses were few in number compared to barley. Many of the entire barley caryopses were recognisable as the small 'tail' grain. It is suggested from these results that hay and straw fodder was supplemented with the fine cleanings from cereal crop processing, to which some grain may have been added. Robinson & Rasmussen (1989) found crop waste was a supplement to leaf fodder at Weier, N.E. Switzerland. As wheat is a more valued crop than barley, taking longer to grow and being more dependent on good weather to give a high yield, it is perhaps not surprising that the Oakbank fodder was supplemented primarily with barley, and even this was mainly in the form of tail grain. Wheat bran found in the matrix is likely to have been from grain retained in the spikelet by inefficient threshing, or spoiled crop products. Most of the macrofossil assemblages which contained ovicaprid droppings and unidentifiable faecal matter showed similar plant remains to samples 94C6S4 and 94C6S9, although some were mixed more obviously with household debris of other kinds.

Although many of the cereals present in matrix representing byre conditions were fragmented, entire caryopses were present, and sometimes frequently. Robinson & Rasmussen (1989) observed that sheep and goats chew grain whereas cattle swallow it intact, such that it must be split before consumption to allow the animals to digest it. For goats and sheep the addition of heavy chaff and fine cleanings to the fodder would then have the dual purpose of ensuring that the food was properly chewed as well as bulking out the meal. For cattle the added grain would require either boiling or grinding to split it. The presence of both fragments and intact caryopses of cereals in the byre matrix at Oakbank could suggest their passage through the gut and incorporation into the matrix as unidentifiable faeces from cattle eating prepared grain with added chaff containing tail grain. However, intact caryopses could just as easily represent loss into the matrix of entire, uneaten grain with chaff. Fragments may be a result of digested faecal remains from any domesticated herbivore, or may represent poor preservation of individual caryopses. A combination of the two is suspected.

The presence of faeces in the matrix in sample 94C6S9 other than the identifiable droppings was suspected from its texture, colour and general appearance. This was confirmed by the discovery of two *Trichuris* L. (whipworm) eggs in it, found using the method described by Dainton (1992).

Several ovicaprid dropping fragments from 94C6S9 were teased apart in water under low power microscopy for a brief analysis of their contents. This revealed fragments with the appearance of cereal bran, plant and animal hairs, plant cuticle, and other non-woody remains. No leaf tissue was revealed, precluding leaf foddering when these droppings were incorporated. Leaf tissue remained in droppings at Weier to demonstrate leaf fodder there (Robinson & Rasmussen 1989). While time did not permit further macrofossil study of the droppings, these preliminary results show the potential for further work in this area.

One entire goat dropping from 94C6S9 was prepared for pollen analysis as a preliminary investigation into the potential for the study of pollen and spores in faeces at Oakbank. The results are shown in table 7.1. The dropping proved to be very rich in these microfossils, the vast majority of which were in extremely good condition. The analysis shows an overwhelming abundance of Poaceae pollen, of a size synonymous with wild grasses, together with higher than usual values for cereals, and low levels of a variety of grassy wasteland species. Two pollen types not represented in the macrofossil assemblage were noted, namely *Lysimachia vulgaris* (yellow loosestrife), a colonist of damp areas near lakes, rivers and marshes, and *Succisa* (Devil's-bit Scabious), of which a single grain is of no significance.

The scant presence of *Carex* species nutlets in the matrix of 94C6S9 agrees with the low levels of Cyperaceae pollen in the dropping. This suggests that hay cut here was not significantly from areas of damp meadow. When compared to the situation found in 94C6S4, where *Carex* species macrofossils were more common, this implies a general view of hay being cut from areas with varying water levels.

Pollen type	total grains	%TPS	%TPS excl. Poaceae
Alnus	33	2.2	6.8
Coryloid	19	1.3	3.9
Salix	4	0.3	0.8
Betula	36	2.4	7.4
Quercus	2	0.1	0.4
Ulmus	1	0.1	0.2
Poaceae	985	66.9	
Pteridium	60	4.1	12.3
Cereal type	46	3.1	9.4
Filicales	45	3.0	9.2
Calluna vulgaris	44	3.0	9.0
Plantago lanceolata	23	1.6	4.7
Lysimachia vulgaris type	21	1.4	4.3
Artemisia	20	1.4	4.1
Ranunculus acris group	20	1.4	4.1
Cyperaceae	16	1.1	3.3
Potentilla type	11	0.8	2.2
Aster type	8	0,5	1.6
Caryophyllaceae	7	0.5	1.4
Filipendula	5	0.3	1.0
Lactuceae	5	0.3	1.0
Rumex	4	0.3	0.8
Ranunculus acris type	3	0.2	0.6
Anthemis type	3	0.2	0.6
Apiaceae	3	0.2	0.6
Rumex acetosa group	3	0.2	0.6
Ericaceae	2	0.1	0.4
Plantago media/major	2	0.1	0.4
Urtica	2	0.1	0.4
Silene dioica type	1	0.1	0.2
Succisa	1	0.1	0.2
concealed/crumpled	38	2.6	7.8

Table 7.1. Results of the pollen analysis of a goat dropping from 94C6S9

In general the pollen represented in the goat dropping is sufficiently similar to the macrofossil assemblage from the surrounding matrix to confirm that the animal had eaten fodder comparable to that in the immediate vicinity. As the process from consumption to production of faeces would be expected to span several hours, it can be concluded that the animal was either housed and fed inside at the time, or had eaten the same food elsewhere.

The presence of *Pteridium* and Filicales (ferns) spores may be from close contact in the matrix, the result of animals nibbling bedding, spores from bedding falling on to fodder, or from community association. No Filicales macrofossils were found at Oakbank apart from one *Dryopteris filix-mas*, which may emphasise preferential collection, or low levels of other fern species may have been overlooked in the presence of the enormous quantities of bracken.

The presence of pollen of trees including alder, birch, willow and hazel is interesting considering all flower in early spring, and the overwhelming majority of the pollen including small Poaceae, bracken and fern spores and flowering herbs points to late summer collection. Levels are not high compared to those viewed by Rasmussen (1993), however, but may imply that fodder was given to the animals in early spring when tree pollen was high, or that the animals ate hay which had grown at the margins of open, damp woodland. A few poorly preserved buds were noticed in the matrix, along with occasional twigs, but no woody fragments were observed in the ovicaprid dropping fragments dissected. Pollen from these tree species may have resulted in this case from drinking water given to the stalled animals.

Cereal pollen was also very high compared to what would normally be expected, as cereal pollen is mostly retained in the spikelet. These results concur with the hypothesis of stalled animals feeding on hay, to which cereal chaff and crop remains were added. Again, the possibility of contamination by close association is recognised, but not thought to be wholly the reason. The presence of *Calluna vulgaris* remains in the matrix of 94C6S9 is emphasised by the noticeable quantities of heather pollen in the dropping analysed. The low level of *Urtica* pollen does not agree with the numbers of seeds found in the matrix, implying nettles were not part of the fodder collected from hay meadows. This is not surprising, but adds weight to the suggestion that nettles were given in addition to the fodder, perhaps in the 'waste disposal scheme' outlined above in this section.

A further *Trichuris* egg was found in material prepared for pollen analysis. This was approximately 55µm long, which compares with the size of eggs from goat faeces at Egolzwil 3 (Rasmussen 1993). Hall *et al.* (1983)

suggest that *Trichuris* eggs shrink during pollen preparation. It is not clear whether the Egolzwil eggs had undergone treatment for pollen assessment, but if they had not, this suggests that the Oakbank egg was initially bigger than the Egolzwil ones. When the egg from the pollen preparation was compared with those found during the smear test (Dainton 1992) it was noticed that the untreated eggs were in the order of 70μm long, which is considerably more than the treated one. It does put the eggs from the untreated faeces to within the size range of *Trichuris ovis*, however, which is a parasite of goats, sheep and cattle (Soulsby 1982).

Some of the pollen or spore types found in the dropping may have resulted from close association with the surrounding matrix, for example some or all of the *Pteridium* spores, but this cannot always be the case. Consequently when the pollen results are taken in conjunction with macrofossil evidence from other droppings and the surrounding matrix, it gives a fairly accurate indication of both what the animals were eating, and the ecological area(s) from which the fodder was taken.

One goat dropping pollen analysed by Scaife (Clapham & Scaife 1988) was taken from an unknown context during the early excavation of area B, probably B4 (Scaife pers. comm.). Although largely similar to the results from the 94C6S9 dropping (see table 7.2.) there are some interesting differences, including high values for Coryloid, *Dryopteris* and *Odontites* types, *Pteridium* and *Urtica.* Similarly the values for *Calluna vulgaris* and Poaceae are lower. These discrepancies may relate to differences in types of fodder or season of collection, or may be from animals browsing directly on the shore. The pollen from this dropping cannot be compared to macrofossils from the surrounding matrix here since it was manually collected and not as part of a box sample. As mentioned previously, some of the higher pollen or spore values may result from contamination from the surrounding environment, especially the *Pteridium,* but the lack of stratigraphic data or discussion in the text precludes any further assumptions. It is not sensible to make further comparisons between the C6 dropping and that from B4, since the stratigraphy and spatial positioning of the latter is not understood.

Pollen type	%TPS 94C6S9	%TPS (C & S 1988)
Alnus	2.2	1.4
Anemone type		0.4
Anthemis type	0.2	
Apiaceae	0.2	7.3
Artemisia	1.4	0.9
Aster type	0.5	
Betula	2.4	
Calluna vulgaris	3.0	0.9
Caltha type		0.9
Caryophyllaceae	0.5	
Cereal type	3.1	2.0
Cirsium type		0.9
cf Hypericum		0.4
Coryloid	1.3	17.3
Cyperaceae	1.1	0.9
Dianthus type		1.4
Dryopteris type		16.4
Ericaceae	0.1	
Filicales	3.0	
Filipendula	0.3	1.0
Lactuceae	0.3	
Lysimachia vulgaris type	1.4	
Medicago type		1.0
Odontites type		6.7
Plantago lanceolata	1.6	1.4
Plantago media/major	0.1	
Polypodium		1.3
Poaceae	66.9	34.7
Potentilla type	0.8	0.4
Pteridium	4.1	18.7
Quercus	0.1	
Ranunculus acris group	1.4	
Ranunculus acris type	0.2	
Ranunculus type		1.7
Rhinanthus type		6.3
Rosaceae undiff.		0.4
Rumex	0.3	0.9
Rumex acetosa group	0.2	
Salix	0.3	
Silene dioica type	0.1	
Sphagnum		0.9
Sorbus type		0.4
Succisa	0.1	0.9
Taraxicum type		0.9
Trifolium type		0.9
Ulmus	0.1	
Urtica	0.1	9.0
concealed/crumpled	2.6	

Table 7.2. Pollen from a goat dropping in 94C6S9 compared to the Clapham & Scaife (1988) ovicaprid dropping analysis

In general, the pollen evidence considered here is only a minor component of this study, but serves to highlight the potential for a detailed analysis into the animal husbandry practices employed by the inhabitants of Oakbank crannog.

7.4. Miscellaneous Uses of Higher Plants at Oakbank Crannog

The modern way of living is designed upon a use and throw away mentality, which can be paralleled by the situation which must have existed throughout pre-history, although in a different sense. Where we rely today on synthetic, manufactured items, the ancient communities depended on their natural environment to provide necessities and home comforts which were discarded after use. Ingenious utilisation of wild and crop plants and their residues provided the basis for the Neolithic change away from a nomadic way of life, which ultimately resulted in the complex civilisations witnessed throughout history.

The environmental investigations at Oakbank crannog have highlighted the potential uses of many plants in household capacities, including human and animal food, housing, thatching, bedding, medicinally, and other miscellaneous ways. Remains of taxa utilised for food and building materials have provided proof of the basic household economy at Oakbank, but many other plant species are prolific in the assemblages found. Although it is not possible to be so definite about the reasons why many of these species are incorporated, and indeed this may be different in various locations on the site, it is feasible to suggest plausible explanations for their uses.

7.4.1. Thatching, Flooring and Bedding

The plants which come into this category could have been used for any or all of these uses which in common rely on long stranded stems. In terms of thatching material it is not possible to be specific due to the collapsed nature of the site and its confused nature of its stratigraphy. Nevertheless the circumstantial evidence does allow speculation on this point.

Remains of *Pteridium aquilinum* (bracken) are ubiquitous and prolific throughout the site. As a thatching material, bracken is good, lasting 20 years or so before it needs to be replaced. Only heather outlasts it in Skye (Rymer 1976). This was long enough for the short tenancies of the old Western Isles crofts, and realistically is likely to be as long as a crannog could last without needing some refurbishment. In this sense bracken would have made a perfectly satisfactory thatch. *Phragmites australis* (reed) and *Cladium mariscus* (great fen-sedge) are generally accepted as the best thatching material, but are entirely absent from Oakbank. *Phragmites* does grow in Perthshire, albeit at some distance from the site, but *Cladium* is not common in Scotland (Perring & Walters 1976). Differential preservation of the caryopses is recognised as a possibility (Hall 1986) but discounted in the presence of more immediately available alternatives, and the absence of any culm evidence whatsoever. Considering the size of the site and the range of sampling areas, some at least would have been expected.

Rymer (1976) indicates two methods of thatching with bracken. The first, and more ancient, involves the cutting near to the base of tall, mature fronds in the late summer, when the rachis had achieved maximum length without becoming brittle, and stripping it free of pinnae. Bundles of rachis would then be used in the same manner as reeds or straw. The second method of thatching with bracken was common in the last two hundred years, and employed the pulling up of the entire plant in late summer, including the small bulbous rhizome. This was then treated in the same manner as before, but the rhizome was exposed to the elements. A modern reconstruction of this is reported in the refurbishment of the Jean McAlpine Inn at Aberfoyle (Harrison 1994). This method effectively removes the plant from the area, however, and it is clear that the ancient method of harvesting the fronds without the rhizome would be a more satisfactory way of utilising this natural resource but maintaining its growth for future use (Rymer 1976). The great abundance of bracken at Oakbank suggests its high possibility as a thatching material, especially since some was found lying in parallel orientations as if it had been bundled together. In several of the site locations long, mature bracken rachis was found in abundance, but pinnae were very sparse. This situation suggests thatching material. No rhizome material was found, but this would not be expected if only rachis were used.

The abundance of bracken in all contexts on the site means it is highly likely to have been used for byre and household flooring at Oakbank as it is more absorbent than straw (Rymer 1976). Many contexts containing bracken reveal equal proportions of rachis and pinnae, suggesting entire fronds. Bracken has been recovered frequently in flooring or bedding contexts on archaeological sites (eg Medieval Perth; Robinson 1987) and was used as bedding at the Roman site of Vindolanda (Seaward 1976) and in Fortingall village near Oakbank until fairly recently (Rymer 1976).

Some, but not all of the Oakbank bracken pinnae had sporangia present, attesting to their late summer collection. This is the best time to take fronds without damaging the vigour of the plants (Rymer 1976). The fact that some did not display sporangia suggests that there was enough bracken about for it to be gathered at other times of the year without concern for the survival of the 'crop', although some degree of control of the utilisation of this valuable resource is likely when one considers that it would not have been the extensive weed it is today. The young shoots may also have been eaten in times of want by man or beast and have known antihelminthic properties (Rymer 1976; Stuart 1989).

Although bracken may have been used as thatch there are other possibilities for this, and some may have been used in conjunction. Long stemmed rushes including *Juncus effusus/conglomeratus* and *J. articulatus/ acutiflorus* have been found consistently on the site. Further separation of these types of species other than as outlined above was not deemed a sensible use of time, as they inhabit similar places, are as frequently occurring, and have identical growth habits. They would have been collected for similar purposes. It would take a phenomenal amount of rushes to make satisfactory thatch, but it would be useful to supplement or add to an existing thatch, depending on the season when repair was necessary. *Juncus* stems are long even in spring when bracken is short and straw is not available. The primary use for the long stemmed rushes at Oakbank was probably to cover the floor on a recurring basis, and the manufacture of rush lamps, however. Rushes, often sweetened with wild flowers including *Filipendula ulmaria,* were frequently used in medieval towns as floor coverings, and are suggested at York (Hall 1986).

The *Juncus* spp seeds from Oakbank samples examined by Clapham & Scaife (1988) were interpreted as coming from the natural bank in the water, but this is disputed as the seeds in this study are so numerous, and other water-borne species are so very poorly represented. In some cases the entire capsules and seed heads were present, suggesting a loss on the site. Also Clapham did not attempt to count the *Juncus* seeds and that study did not account for different localities on the site, so he was unable to see that some areas had far more rush seeds than others. This has implications for their use.

Straw from cereal processing can also be used for thatching (Hall 1986), but at Oakbank the incidence of low growing cornfield weeds are such as to suggest reaping low on the culm with a sickle, and consequently this rules out straw thatch (Hillman 1984, 1986), as threshing will break the culm. Straw intended for this purpose was commonly hand picked at ear height, and reaped separately later. Straw rope was found during the early excavation of the site (Dixon pers. comm.), but in samples analysed for this study scant culm nodes and occasional culm in the matrix were all that remained from this resource. It may be that most of the straw was fed to livestock or used to stable them, and rotted away with the moisture. Straw remains were only very noticeable in samples which had chaff and wild species interpreted as byre fodder. Other uses for straw in antiquity were bedding and flooring, which would account for small scale occurrences in the crannog generally.

There is insufficient evidence of *Calluna vulgaris* to suggest its role as a thatching material. In the samples analysed from Oakbank heather may have been intended for rope, packing, dyeing, bedding or other purposes.

Species indicating short turf were not encountered in samples taken for this study except in sample 91C1S5. This could have been from underthatch (e.g. Fenton 1978; Kenward & Hall 1995), as a wind guard between or over walls, or possibly to bank the fire. However in the absence of charred vegetative turf remains such as *Carex* rhizomes, it is more likely that turf from this sample at least was for another purpose. Turves cut for firing would more commonly contain fruits of short stemmed species also, which is not the case at Oakbank. Only *Danthonia decumbens* cleistogenes and small grasses such as *Agrostis* and *Poa* species fit into this category. Thatching turves do grow, and would fruit if used on the apex, for example, but here the seeds of long fruiting stem species and the associations in which they were found implies use as hay for fodder or bedding.

In summary, although it is not possible to be certain, it seems probable that bracken was used at Oakbank for the majority of thatching and flooring. A wooden roof would have been too heavy, and there is not enough birch bark present to illustrate the use of that. Straw or rushes may have been used but only in part, if small repair was required outwith the optimum collection time for bracken. There is insufficient heather to imply its use as thatch. Bracken, straw and rushes are likely to have been used as floor coverings whenever each was abundant. Rushes are particularly resilient in this respect. Turves could have been incorporated in roofing fabric but cannot be proven here. Cereal straw and hay from heath and grassy areas were probably employed as bedding or fodder, as demonstrated by the pollen analysis of the ovicaprid droppings

7.4.2. Fibres; *Linum usitatissimum* (Flax) and *Urtica dioica* (Nettle)

Oakbank crannog is not a land based site, and consequently has no evidence of retting pits such as those found at West Row Fen (Martin & Murphy 1988). It may also be that the husbandry of sheep and goats on the site precluded the need for extensive fibre production. Weaving and spinning equipment, and woven wool cloth of a two-one twill type have been recovered from the site attesting to this point (Dixon, pers. comm.).

The seeds of potential fibre plants are present on Oakbank, however, including flax and nettles. Both fibres and oil can be taken from the same plant of *Linum usitatissimum*, but with a resultant decrease in the volume of oil and poorer quality of fibre (Winton 1916; Bond & Hunter 1987). However in this case it is impossible to say whether the species was utilised for fibre at all Similarly *Urtica dioica* is an opportunist weed, although it does not flower in its first year (Greig-

Smith 1948). Its presence as seeds on the site could demonstrate the utilisation of this species for rope and other purposes, since a coarse nettle fibre is made by simply splitting the stems and peeling the epidermis. It could represent periods of abandonment longer than one season or accidental incorporation, but regularly high numbers of nettle seeds does imply intentional collection.

7.4.3. Plants as a Source of Oil

Linum usitatissimum seeds and capsules are present in six of the eighteen samples analysed. The seeds release 35-44% good quality oil when pressed, leaving 24% protein cake which makes a nourishing animal fodder (Vaughan 1970). Seeds at Oakbank were frequently in contexts suggestive of animal husbandry, and were commonly in poor condition compared to other macrofossils, as would be expected if the seeds had been processed. It is likely that some flax seeds were pressed for oil to supplement sources of animal tallow. Others could have been used to flavour food.

Papaver somniferum seeds contain 40-55% high grade oil and when pressed the cake retains 37% protein which is a valuable animal fodder (Vaughan 1970). Opium poppy was exploited as an oil crop by the Neolithic Swiss lake communities. The large pressed cake of opium poppy seeds from Robenhausen (Heer 1866) is suggestive of such a use, and opium poppy and flax were thought to be the main oil crops at the Niederwil (van Zeist & Casparie 1974). The opium poppy seeds at Oakbank are not frequent enough to suggest other than potential use as an oil plant, however.

Brassica rapa ssp *campestris* was in many samples at Oakbank and also has potential as an oil seed species but its close association in samples with crop assemblages make it more likely to have occurred here as a crop weed.

7.4.4. Evidence of Garden Cultivation; *Papaver somniferum* (Opium Poppy) and Flax

Although only three opium poppy seeds were found at Oakbank, their presence on the site at all is extremely interesting. The species is not known so early in

Scottish pre-history, although several English records exist including the Bronze Age Wilsford Shaft (Robinson 1989), and the Iron Age Fifield Bavant (Helbaek 1952). The species is recorded from British Roman sites, e.g. Straker *et al* (1984), Dickson (1989), Carruthers (1991), Murphy (1992).

Opium poppy is a member of the secondary crop assemblage which entered Central Europe with the spread of agriculture from the Near East (Zohary & Hopf 1993) with origins as a cultigen in Turkey (Simmonds 1976). It has been found on archaeological sites in Europe since the Neolithic (see Renfrew 1973) where its value as a medicinal plant, for oil, and as a food flavouring have been recognised. The Minoan civilisations employed its narcotic effects extensively in religious ceremonies, and statues of the Greek god Hypnos (of sleep) carry a capsule in their hand (Godwin 1978). An ancient Egyptian herbal cites opium poppy seed to be mixed with fly dung and fed to a crying child who will immediately stop! (Manniche 1993). However, as the seeds do not contain the narcotic effects (Renfrew 1973, Frohne & Pfänder 1983) it may be that the benefits of this cure are in the threats to carry it out rather than its magical properties!

The latex extracted from unripe opium poppy capsules contains more than 30 alkaloids (Renfrew 1973) from five principal bases (Frohne & Pfänder 1983). It is still a source of commercial morphine (Godwin 1978). Before modern methods of extraction of alkaloids from the raw latex were available, salves and pastes were made using the latex itself or even just pulverised green capsule tissue. The percentage of alkaloid bases synthesised depends on the form of poppy, but within limits dependent on soil and climatic factors (Frohne & Pfänder 1983). Opium poppies makes the active ingredients in the English fenlands (Godwin 1978) but it is unclear if this is still feasible as far north as Loch Tay. If so, then cultivation for medicinal purposes is possible at Oakbank.

Opium poppy seeds have been found in sewage contexts at Roman sites (e.g. Dickson 1989) and in medieval towns (Fraser & Dickson 1982) indicating their direct consumption. A capsule may contain 7-11,000 seeds (Salisbury 1961) and is much larger than that of its wild progenitor *Papaver* *somniferum* ssp *setigerum.* The cultivated form also retains its seed (Zohary & Hopf 1993) such that it would not be likely to be a crop contaminant in the same way that other *Papaver* species can be. It is possible that the Oakbank poppy seeds represent garden cultivation for flavouring, oil or medicinal purposes. Cultivation in such a scale is known from the Neolithic Eberdingen-Hochdorf in Germany (Küster 1985) where *Papaver somniferum* was found with *Petroselinum crispum*. The opium poppy from Fishbourne Palace gardens suggests a Roman garden escape (Carruthers 1991)

It is possible that *Papaver somniferum* was grown in garden plots, or was an imported trade item. *Linum usitatissimum* is also hard to cultivate, as it requires well drained soils (Renfrew 1973), and does not compete well with weeds (Bond & Hunter 1987). Because of this its cultivation in a garden situation is suggested by Murphy & Scaife (1991) and Greig (1991). Flax was found at the Neolithic site of Balbridie, Scotland (Fairweather & Ralston 1993), where a burnt building was dated on the basis of some of the carbonised crop assemblages found.

Flax and opium poppy are not found concurrently in any samples analysed, however, which may be significant. Unfortunately the precise site chronology is not known so it is impossible to say whether they were grown simultaneously during the same phase of site. Flax is much more frequent in area A2 of the site than anywhere else, representing household midden material where much waste has been dumped. The opium poppy seeds are all from area C6, and the two species may not represent the same phase of site.

It is not possible to say whether opium poppy was traded or locally grown, but it has significance for the status of the site in an archaeological context. Opium poppy must have been initially traded into the area, as it is not a species liable to have been a crop contaminant due to the large capsule size.

7.4.5. Medicinal Plants

Practically all wild plant species have some medicinal value, and it is not the purpose of this study to review the literature in this respect. Many of the more commonly known species are also frequent as weeds and cannot be discounted as such from the Oakbank assemblage. This includes *Filipendula ulmaria*, a source of salicylic acid, *Plantago major,* favoured as a poultice for wounds, *Prunella vulgaris* and *Potentilla erecta*, both of which have healing properties. The argument for *Prunella vulgaris* in a medicinal sense is somewhat stronger than that for the others in that it recurs frequently in samples, and in larger numbers than other grassy waste land species. However, in the absence of direct evidence this is still circumstantial.

Even when a plant is still known and acknowledged for its medicinal properties, such as *Papaver somniferum* latex, or *Linum usitatissimum* seed oil, it is not possible to be certain of its use in this respect in the absence of conclusive circumstances, (e.g. paste in a jar). This fact is recognised in Hillman (1986). Consequently it is enough to acknowledge the potential many of the species in the Oakbank list have in a medicinal sense, without being more specific.

7.4.6. Drinks and Flavourings

The use of wild plant parts to flavour drinks is an important ancient practice. No absolute proof of any species being used in this capacity was found at Oakbank crannog, but certain possibilities exist. It is acknowledged that what follows is conjecture, but certainly highly feasible.

Filipendula ulmaria flowers improve the flavour of mead and wine (Dickson 1978, Stuart 1989) and pollen evidence has determined this occurrence. However, the species can also be employed medicinally for its salicylic acid content, or the flowers scattered to sweeten flooring material, so its use in drinks cannot be proven here. Other potential sources of drinks/flavourings include *Betula* species (bark and sap), ground roasted *Galium aparine* seeds and acorns. All soft fruits found on the site can be used to flavour food and drinks too, and the use of *Prunus spinosa* in this context is described by Renfrew (1973). The use of barley in a brewing context needs no further explanation.

7.4.7. Dye and Tanning Sources

None of the more commonly known dye plants such as *Isatis tinctoria* (woad) or *Reseda luteola* (dyer's rocket) were found on the site, but one seed of *Mercurialis perennis* (dog's mercury) was recorded by Hansson (1988), and pollen was found in the organic matrix by Scaife (Clapham & Scaife 1988). This poisonous plant is a source of a blue dye, and may have been collected for this. Other species with past connections in the dyeing industry found on the site by this author include *Calluna vulgaris, Filipendula ulmaria, Lycopus europaeus, Alnus glutinosa, Quercus* sp, *Vaccinium myrtillus/vitis-idaea, Betula* spp, *Prunus* and *Rubus* spp and *Pteridium aquilinum*. The tree species and bracken are employed for their high tannin content. Many of the above were noted in this context in medieval Perth deposits (Robinson 1987).

7.4.8. Miscellaneous Uses

Man's ingenuity in times of need holds no bounds. The utilisation of *Galium* species to strain hair out of milk is reported by Mabey (1996). *Arctium lappa/minus* could be used to the same effect, whilst the young shoots taste like new potatoes or can flavour drinks, and the large, mature leaves make excellent butter pats (Mabey 1996). The large leaves of docks can also be used to this effect.

7.5. Utilisation of Mosses on Oakbank Crannog

The division Bryophyta includes the mosses, liverworts, and hornworts, although only mosses are frequently recovered from archaeological deposits (Dickson 1986). In common with the rest of the Bryophyta, mosses are found in all types of shady, damp habitats. Their identification to species is a specialist subject in itself. For the purpose of this project the emphasis was laid only on those mosses which may have been gathered intentionally by the Oakbank community for various uses. Consequently it is only large mosses from the macrofossil assemblage which have associations with people that have been rigorously identified, with the acknowledgement that other species with a small growth habit have been excluded. These small types are indicative of environmental conditions, but their reason for incorporation into human influenced archaeological deposits is chance occurrence, for example with a felled tree or cut turf (Dickson 1986).

Weft-forming mosses have a pleurocarpous (horizontal) growth habit and form dense, flattened mats with a two-dimensional branching pattern over rocks and trees in damp shady areas. This shape contrasts with the acrocarpous (upright) growth habit of the tussock forming species, where domes of leafy stems often have their rhizoids embedded in soil.

Growth habit as much as size determined selection for specific human uses in antiquity. The large wefts useful for packing and wiping can be easily ripped up in handfuls, and also do not have the problem of adherent soil often found with acrocarpous mosses of small growth habit. The largest of the acrocarpous mosses have their own particular uses in antiquity for rope and small item weaving. *Polytrichum commune* is well known in this respect, as photographed in Dickson (1973) in the form of caulking rope. No remains of this species were found at Oakbank, but it is well known in the fossil record. The use of *Calluna vulgaris* as rope material may have been preferred at this site. *Sphagnum* species are also acrocarpous, but are distinct in their particular properties of water absorption which have made this genus invaluable to man throughout time. A few leaves of *Sphagnum* remain in Oakbank samples as a testament to the availability for use of the genus at the time.

The large weft-forming species identified from Oakbank include *Antitrichia curtipendula, Calliergon cuspidatum, Eurynchium cf striatum Eurynchium* sp., *Hylocomium splendens, Hypnum cupressiforme, Neckera complanata, Pleurozium schreberi, Rhytidiadelphus squarrosus and Thuidium tamariscinum.* From the number of samples that each of these species was found in it is clear that some were more favoured than others. Within this grouping *Neckera complanata* was in eleven out of eighteen samples, *Hylocomium splendens* was in eight, and *Hypnum cupressiforme* and *Sphagnum* species five and six respectively. These species would have been abundant in the established woodland in the vicinity of the crannog. It is likely that they were recognised as useful by the Oakbank community, and were selectively gathered whenever possible. Human nature is such that familiarity with a species for specific purposes might encourage its collection for them in the future. Other species may have been collected in a less methodical manner. *Pleurozium schreberi* was only in one out of a possible eighteen samples, but it grows in close association with *Hylocomium splendens* and has a similar habit. The species was possibly gathered simultaneously in sample 91C1S8, either intentionally to increase the volume gathered, or accidentally from a mixed community. *Pleurozium schreberi* may not have been common in the locality of the crannog due to its scarcity on base-rich soils.

Small amounts of smaller growth habit pleurocarpous and acrocarpous species were recognised in samples, but not methodically identified due to constraints on time and the emphasis on species connected with human activity. None are particularly connected with human usage in the past. These were never frequent compared to levels of species useful to humans, and their presence on the site is considered to be chance incorporation with other mosses or resulting from various domestic activities, including bringing in firewood and fodder or on boots and hooves.

Ancient uses for mosses are prolific. The dense springy morphology of the larger weft-forming mosses make them ideal for a variety of uses including weather-proofing walls and cracks in the floor or roof, and improving comfort in bedding. Keller (1878) reports some of the large pleurocarpous species being used for these purposes in the Neolithic Swiss lake dwellings, including *Antitrichia curtipendula* and *Neckera complanata* which were also at Oakbank. The presence in some abundance of *Neckera complanata* and *Hylocomium splendens* in all areas of the Oakbank house site suggests the possibility of these species being used for some such generalised purpose. Other uses for weft-forming mosses include all sorts of small scale packing activities, such as providing an insulation layer in boots for cold feet or as padding for tool handles. The possibly unique discovery of a Mesolithic flint flake with a padded handle of *Hylocomium brevirostre* from the River Bann (photographed in Dickson 1973 plate 21) probably reflects a frequency of use previously only guessed at before this fortunate preservation. The weft- forming mosses have also been used for a wide variety of wiping duties including cleaning pots and for toilet purposes. Mosses are well known from latrine fills (eg Hall 1986, Dickson 1986, Dickson & Brough 1989, Robinson 1987, Hall & Kenward 1990, Kenward & Hall 1995) and their application in a toilet capacity must have been commonplace. There is a suggestion of human faeces in samples from areas A2 and A3 at Oakbank where fragments of cereal bran and wild fruit seeds are mixed with quantities of moss, but no absolute proof of human coprolites has been found in the course of this investigation. This is hardly surprising as the obvious place to deposit faeces on a crannog site is into the water.

Other wiping/absorptive functions of the larger mosses are as bandages and babies nappies. In this respect the weft-forming species are preferable to the long-stemmed acrocarpous types, but with the notable exception of *Sphagnum* species. The bog mosses are particularly useful for wound dressings, nappies, or any purpose requiring intensive absorption due to their phenomenal properties of fluid retention and acidifying effects which inhibit bacterial growth. The genus has been used in recent wars as emergency field dressings. The larger acrocarpous species such as *Polytrichum commune* have been used in antiquity for rope and weaving applications (Dickson 1973), but this is not demonstrated at Oakbank. Specific uses for any of the species mentioned above cannot be corroborated at Oakbank.

CHAPTER 8: COMPARATIVE DISCUSSION OF RESULTS

8.1. Discussion of Results Compared to Those of Previous Oakbank Studies

8.1.1. Macrofossil Results

The macrofossil results obtained from samples examined during the course of this investigation compared to those of previous authors are shown in table 8.1. However, none of the previous studies were as intensive as the current one, and did not identify problematic macrofossils with such thoroughness. As a result of this the information forthcoming from them about the general economy and environment of the site has not been as detailed and comprehensive as that which has come from this present study. Nevertheless these few initial small scale works highlighted the potential for this current major study. They confirmed the basic propositions considered earlier in this text about crop husbandry regimes through their disclosure of numbers of the same common weeds that were so frequently encountered during this study. This implies their abundance throughout the site in general.

Previous studies also added one or two seeds of species not found during this investigation. *Daucus cf carota* and *Mercurialis perennis* are important to note in this respect, since the former is a potential food plant, and the latter is a source of blue dye, although highly poisonous (Frohne & Pfänder 1983). Both are single seeds, however, and could simply be chance occurrence from the local vegetation. Interestingly, *Artemisia vulgaris* or *A. cf vulgaris* was noted by the minor studies of Stokes (1984), Clapham (Clapham & Scaife 1988) and Hansson (1988), but was not found anywhere in the course of the present intensive work. The large, fairly distinctive fruit would not have been accidentally overlooked, given the degree to which other more problematic seeds were identified. Asteraceae in general were not well represented in the course of this study, however, although one or two individual species recurred frequently.

SPECIES NAME	COMMON NAME	M	S	C	H
Agrimonia eupatoria L.	Agrimony	+			
Agrostis sp L.	Bents	+			
Ajuga cf pyramidalis L.	Pyramidal Bugle				+
Ajuga reptans L.	Bugle	+		+	
Alnus glutinosa (L.) Gaertner	Alder	+		+	+
Alnus sp Miller	Alders	+			
Anagallis cf arvensis L.	Scarlet Pimpernel	+			
Anagallis sp *(cf)* L.	Pimpernels			+	
Aphanes arvensis L.	Parsley-piert	+		+	+
Aphanes inexpectata Lippert	Slender Parsley-piert	+			
Apiaceae	Carrot family		+		
Arctium lappa/minus L./(Hill) Bernh	Greater/Lesser Burdock	+			
Artemisia cf vulgaris				+	+
Artemisia vulgaris L.	Mugwort		+		+
Asteraceae	Daisy Family	+	+		
Atriplex sp L.	Oraches			+	
Avena sp L.	Oat	+			
Bellis perennis L.	Daisy			+	
Betula pendula Roth	Silver Birch	+			
Betula pendula/pubescens		+			
Betula pubescens Ehrh	Downy Birch	+			
Betula sp L.	Birches	+		+	
Brassica rapa ssp *campestris* (L.) Clapham	Wild Turnip	+			
Brassica sp L.	Cabbages			+	
Bromus hordeaceus L.	Soft-brome	+			
Bromus sp L.	Brome	+			
Calliergon cuspidatum (Hedw.) Kindb.	(moss species)	+			
Callitriche stagnalis Scop.	Common Water-starwort	+			
Calluna vulgaris (L.) Hull	Heather	+			
Campanula rotundifolia L.	Harebell	+			

Table 8.1. List of plant species identified at Oakbank crannog by the author compared to those of Stokes (1984), Clapham (1988) and Hansson (1988), with their common names where appropriate. (continues overleaf)

Presence is marked '+'. No figure is put on relative abundances. This is discussed in the text where appropriate.

Column M: species identified by Miller.
Column S: species identified by Stokes.
Column C: species identified by Clapham.
Column H: species identified by Hansson.

Authorities and common names for higher plants follow Stace (1991), Clapham *et al.* (1987) and Renfrew (1973) where appropriate.
Moss authorities follow Watson (1995).

SPECIES NAME	COMMON NAME	M	S	C	H
Carex flacca Schreber	glaucous sedge	+			
Carex hostiana DC.	Tawny sedge	+			
Carex nigra (L.) Reichard	common sedge	+			
Carex ovalis Gooden.	Oval sedge	+			
Carex panicea L.	carnation sedge	+			
Carex pilulifera L.	pill sedge	+			
Carex rostrata Stokes	bottle sedge	+			
Carex sp L.	sedges	+		+	+
Carex sylvatica Hudson	wood-sedge	+			
Carex viridula (*s.l.*) Michaux	yellow-sedge	+			
Carex viridula cf ssp *oedocarpa* (Andersson) B. Schmid		+			
Caryophyllaceae sp	pink family		+		+
Centaurea cf nigra L.	common knapweed	+			
Cerastium cf arvense L.	field mouse-ear				+
Cerastium fontanum Baumg.	Common mouse-ear	+			
Cerastium glomeratum Thuill	sticky mouse-ear	+			
Cerastium sp L.	mouse-ears	+			
Chenopodium album L.	fat-hen	+			+
Chenopodium cf album				+	
Chenopodium sp L. (Blitum L.)	goosefoots		+		+
Corylus avellana L.	hazel	+		+	+
Corylus sp L.	hazels	+			
Danthonia decumbens (L.)DC.	Heath-grass	+			
Daucus carota (cf) L.	(wild) carrot			+	
Deschampsia cespitosa (L.) P. Beauv.	Tufted hair-grass	+			
Dryopteris cf filix-mas (L.) Schott.	Male-fern	+			
Empetrum nigrum L.	crowberry	+			
Epilobium montanum L.	broad-leaved willowherb	+			
Equisetum sp L.	horsetails				+
Erica tetralix L.	cross-leaved heath	+			
Fallopia convolvulus (L.) A. Love	black-bindweed	+	+	+	+
Filipendula ulmaria (L.) Maxim.	Meadowsweet	+			
Fissidens sp	(moss species)	+			
Fragaria vesca L.	wild strawberry	+		+	
Galeopsis subg. *Galeopsis* L.	hemp-nettles	+		+	+
Galium aparine L.	cleavers	+			
Galium sp (*cf*) L.	bedstraws	+			
Glyceria fluitans (L.) R. Br.	Floating sweet-grass	+			
Gnaphalium sp (*cf*) L.	cudweeds	+			
Heracleum sphondylium L.	hogweed	+			+
Holcus lanatus L.	yorkshire-fog	+			
Holcus sp L.	soft-grasses	+			
Hordeum vulgare L.	six-rowed barley			+	
Hordeum sp L. (Critesion Raf.)	barleys	+			+
Hypnum cupressiforme Hedw.	(moss species)	+			
Hypochoeris radicata L.	cat's-ear	+			
Isoetes cf lacustris L.	quillwort	+			
Juncus articulatus/acutiflorus L./Ehrh ex Hoffm.	Jointed/sharp-flowered rush	+			
Juncus bufonius L.	toad rush	+			
Juncus effusus L.	soft rush			+	
Juncus effusus/conglomeratus L.	soft/compact rush	+			

Table 8.1. (continued)

SPECIES NAME	common name	M	S	C	H
Juncus sp L.	rushes	+		+	+
Juncus squarrosus L.	heath rush	+			
Lapsana communis L.	nipplewort	+	+	+	+
Leontodon autumnalis/hispidus L.	autumn/rough hawkbit	+			
Leontodon cf autumnalis L.	autumn hawkbit	+			
Leontodon sp L.	hawkbits				
Linum catharticum L.	fairy flax	+		+	
Linum usitatissimum L.	flax	+	+	+	+
Luzula sp DC.	Wood-rushes	+		+	+
Luzula sylvatica (Hudson) Gaudin	great wood-rush	+			
Lycopus europaeus L.	gypsywort	+			
Mercurialis perennis L.	dog's mercury				+
Mnium hornum Hedw.	(moss species)	+			
Montia fontana L.	blinks	+		+	
Montia fontana ssp fontana.		+			
Montia fontana ssp *variabilis*		+			
Myosotis arvensis/sylvatica (L.) Hill/ Hoffm.	Field/wood forget-me-not	+			
Neckera complanata (Hedw.) Hüben.	(moss species)	+			
Papaver somniferum L.	opium poppy	+			
Papaver sp L.	poppies	+			
Persicaria lapathifolia (L.)Gray	pale persicaria	+	+	+	+
Persicaria maculosa Gray	redshank	+		+	+
Plantago lanceolata L.	ribwort plantain	+			
Plantago major L.	greater plantain	+		+	
Plantago sp L.	plantains	+			
Poa annua L.	annual meadow-grass	+			
Poa humilis Ehrh. Ex Hoffm.	Spreading meadow-grass	+			
Poa pratensis L.	smooth meadow-grass	+			
Poa sp L.	meadow-grasses	+			
Poa trivialis L.	rough meadow-grass	+			
Poaceae sp	grasses	+			+
Polygonum arenastrum Boreau	equal-leaved knotgrass	+			
Polygonum aviculare L.	knotgrass	+		+	+
Polygonum hydropiper (cf) L.	water-pepper			+	
Polygonaceae	knotweeds		+		
Potentilla cf argentea L.	hoary cinquefoil				+
Potentilla erecta (L.) Raeusch	tormentil	+		+	
Potentilla sp L. (Comarum L.)	cinquefoils	+		+	
Primula vulgaris Hudson	primrose	+			
Prunella vulgaris L.	selfheal	+		+	+
Prunus cf *padus*				+	
Prunus padus L.	bird cherry	+			
Prunus sp L.	cherries	+			
Prunus spinosa L.	blackthorn	+		+	
Pteridium aquilinum (L.) Kuhn	bracken	+		+	+
Quercus sp L.	oaks	+			
Ranunculus acris L.	meadow buttercup			+	
Ranunculus acris/bulbosus L.	meadow/bulbous buttercup	+			
Ranunculus flammula L.	lesser spearwort	+		+	
Ranunculus repens L.	creeping buttercup	+			+
Ranunculus cf repens			+		
Ranunculus subg. *Ranunculus* L.		+		+	+

Table 8.11. (continued)

SPECIES NAME	common name	M	S	C	H
Ranunculus subg. *Batrachium* (DC.) A. Gray				+	
Rhinanthus minor L.	yellow-rattle	+			
Rhinanthus sp L.	yellow-rattles	+			
Rosa canina L.	dog-rose		+		+
Rosa cf canina		+			
Rosa sp L.	roses	+		+	
Rosaceae	rose family	+		+	
Rubus chamaemorus L.	cloudberry	+			
Rubus fruticosus s.l. L	bramble	+	+	+	+
Rubus idaeus L.	raspberry	+	+	+	+
Rumex acetosa L.	common sorrel	+			
Rumex acetosella L.	sheep's sorrel	+		+	
Rumex cf crispus					+
Rumex crispus L.	curled dock	+		+	
Rumex obtusifolius L.	broad-leaved dock	+			
Rumex sanguineus L.	wood dock	+			
Rumex sp L.	docks	+		+	
Sagina apetala Ard.	Annual pearlwort	+			
Sagina cf subulata (Sw.) C. Presl.	Heath pearlwort	+			
Sagina procumbens L.	procumbent pearlwort	+			
Sagina sp L.	pearlworts	+		+	
Salix sp L.	willows	+			
Scrophularia cf nodosa L.	common figwort				+
Selaginella selaginoides (L.) P. Beauv.	Lesser clubmoss	+			+
Silene dioica (L.) Clairv.	Red campion	+		+	
Sisymbrium officinale (L.) Scop.	Hedge mustard	+		+	
Sisymbrium sp L.	rockets				+
Sonchus asper (L.) Hill	prickly sow-thistle	+		+	
Sonchus sp L.	sow-thistles				+
Sorbus aucuparia L.	rowan	+			
Sorbus sp L.	whitebeams	+			
Spergula arvensis L.	corn spurrey	+		+	
Sphagnum sp	bog-moss	+			
Stachys cf palustris L.	marsh woundwort	+			
Stachys sp L.	woundworts			+	
Stachys sylvatica L.	hedge woundwort	+			
Stellaria cf graminea		+		+	
Stellaria cf media		+		+	
Stellaria graminea L.	lesser stitchwort	+			
Stellaria media (L.) Villiars	common chickweed	+	+		+
Stellaria sp L.	stitchworts	+			+
Torilis japonica (Houtt.) DC.	Upright hedge-parsley	+		+	
Trifolium repens L.	white clover	+			
Trifolium sp L.	clovers	+			
Triticum dicoccum Schübl.	Emmer wheat	+		+	
Triticum/Secale sp L.	wheat/rye	+		+	
Triticum sp L.	wheats	+		+	
Triticum spelta L.	spelt wheat	+		+	
Ulmus sp L.	elms	+			
Urtica dioica L.	common nettle	+	+	+	+
Vaccinium myrtillus/vitis idaea L.	bilberry/cowberry	+			
Valeriana officinalis L.	common valerian	+			

Table 8.1. (continued)

SPECIES NAME	common name	M	S	C	H
Veronica beccabunga L.	brooklime	+			
Veronica cf serpyllifolia L.	thyme-leaved speedwell				+
Veronica chamaedrys L.	germander speedwell	+			
Veronica sp L.	speedwells	+			+
Viola palustris L.	marsh violet	+			
Viola sp L.	violets	+		+	
Viola subg. Melanium	pansies	+			
Viola subg. *Viola*	violets	+			
Violaceae	violet family	+			

Table 8.1. (continued)

Only one seed from this family could not be identified further than Asteraceae (indeterminate), so poor preservation in general is not suspected here. Previous works only recorded low numbers of *Artemisia,* which may be due to chance occurrence of local waste land species, perhaps in fodder. Frequently observed Asteraceae in this study can all be classified as crop contaminants, which suggests why they might have been more frequently encountered.

Table 8.1. demonstrates that some plant species were found in all or nearly all of the past studies as well as the present one. This implies their frequent incorporation into the matrix through intentional use for every day living requirements, and results agree with the suggested reasons for incorporation given previously in this text. The frequency of *Pteridium aquilinum* fragments demonstrates the value of this species on the site, and *Urtica dioica* has been recorded by all studies, suggesting the plant may have been used for some purpose. Nettles are a troublesome weed of occupation areas, but other similar habitat species were not found in such abundance, and as the four studies being compared are from various locations and depths on the site, this suggests a general abundance throughout. Similarly, *Alnus* fruits recorded in the work of both Clapham & Scaife (1988) and Hansson (1988) confirm that it was not just dressed alder piles for construction that were brought on to the site. Alder false cones can persist for up to a year on the branch, so their presence is not related to seasonal incorporation. Nevertheless, they highlight the possibility of uses other than the more obvious constructional ones of parts of the tree, perhaps for fodder, firing or dyeing (Edlin 1973).

Other species occurring in all or most of the previous studies as well as the present one include those brought in with crop and fodder assemblages. As mentioned above, the degree of identification of earlier studies has not been so specific, but it is still possible to retrospectively suggest the origin of these species through their associations now that assemblages have been identified from the present study. It is probable that the *Carex* sp(p) (indeterminate) noted by Clapham & Scaife and Hansson are the same as some of the nine species identified in this text. These have a range of habitats but in general can imply turf or hay from damp or wetter areas. The presence of these *Carex* sp(p) adds further, albeit non-specific, evidence to theories suggested by this author about farming practices and the local environment. The same is suggested for both the caryopses of small Poaceae, identified to species in this text but indeterminate in the reports of Clapham and Hansson and the 70 Polygonaceae seeds recorded in Stokes' work. The other studies discussed here were more specific in their knotweed family identifications, and have consequently found the same range of crop contaminants as this work. These include *Persicaria lapathifolia, P. maculosa* and *Polygonum aviculare s.l.* Further species recognised as being potential crop contaminants in this study which were also in the assemblages of the previous authors include *Aphanes arvensis, Chenopodium* sp, *Lapsana communis, Ranunculus* subg. *Ranunculus, Prunella vulgaris* and *Stellaria media.*

Crop species found in this study compare well with previous ones, with *Hordeum vulgare, Triticum dicoccum, T. spelta* and *Linum usitatissimum* also noted in the earlier works. The same is true for gathered wild food plants, including *Corylus avellana, Prunus spinosa, Rubus idaeus* and *R. fruticosus s.l.* although other species would have been noted had the previous works been more extensive.

The wider scope of the present study has greatly increased the number of species identified from Oakbank crannog. The majority of these exist as low numbers of seeds from only one or two samples scattered throughout the site and probably representing different activities and chance incorporation. This emphasises the need for a wide-area sampling strategy as distinct from a single core down through the matrix like the Clapham & Scaife (1988) study. Where the wide-area sampling method will highlight any specificity of use for each area in the site, the core method will only show changes in the same location with time. There are several problems inherent to coring too, including site slumping mixing the stratified layers. Since there is no way to determine the rate of deposition or how often the floor area was cleaned out, coring may not yield such a variety of information as wide-area sampling. However, this latter method is not ideal either, as it cannot be chronological unless the whole area being studied is excavated and the stratigraphy understood. This was not always the case at Oakbank, where the sheer volume of organic matrix and the complications of an underwater study presented unavoidable difficulties.

It can be seen from the discussion above that both sampling methods have advantages and disadvantages, and may give somewhat different information. A combination of the two would produce the most satisfactory results, especially if backed up with a suite of radiocarbon dates. This sampling strategy would be recommended for future studies if time and finance allowed.

8.1.2. Comparison of this Study with Pollen reports from Matrix Samples in Previous Work

Scaife (1984) did a preliminary report of 300 pollen grains from a small sample from Oakbank, followed by a microfossil study of a longitudinal core from area B4 (Clapham & Scaife 1988) (see figure 8.1.) The pollen evidence in both studies is generally similar to the macrofossil results from this work, although the first one is really too minor to compare. The more detailed core study has some interesting differences to the present study, however, and these are discussed.

The tree pollen values for alder and hazel in Clapham & Scaife's core diagram are much higher than the other tree species, including oak, although this was also extensively used on the crannog. Wood remains of these and other trees utilised at Oakbank were frequent in the matrix samples analysed by this author. Scaife related the high values of alder and hazel to the fringing vegetation, but as the samples were taken from an area within the house suspected to have housed animals, at least occasionally, it is suggested that high pollen values of these species may indicate intentional importation of budded twigs in spring for fodder. Rasmussen (1993) highlights the practice of twig foddering, and catkins have been found on site by this author. Alternatively spring twigs or bark with trapped pollen could have been used for tinder.

A wide variety of non-arboreal pollen was identified in the 1988 core, but many grains were not identified beyond generalised types, which means that detailed closer comparisons with the present work are not possible. For example, *Hornungia* type and *Sinapis* type are both recorded. Together they include all members of the Brassicaceae (Moore *et al.* 1991). The genus *Hornungia* itself is highly unlikely have been at Oakbank crannog due to its southerly distribution, but *Thlaspi arvense* and *Capsella bursa-pastoris* in this type classification are more likely to have been there.

One interesting pollen type to note in Clapham & Scaife's (1988) diagram is that of *Mercurialis*, which is present throughout the column, although only as trace amounts (to 2%).

The only species this is likely to be is *M. perennis* (dog's mercury), since *M annua* (annual mercury) is more southerly in distribution (Perring & Walters 1976). The plant is extremely poisonous (Frohne & Pfänder 1983), and is not likely to have been collected for fodder, but could have been used as a source of blue dye, especially since Hansson (1988) recorded one seed. However, such low levels of evidence are likely to be purely coincidental, and pollen may have become incorporated with woodland weft-forming mosses collected for any miscellaneous use on the crannog.

Other points to note in Scaife's diagram are the high percentages of Poaceae pollen, both wild types and even cereals. Cereals tend to self pollinate and pollen implies their presence *in situ*, which would mean crop processing in this case. The macrofossil evidence concurs with this theory. The extremely high wild grass pollen values are notable too, and add further weight to the suggestion that mixed hay was extensively used on the dwelling, whether for fodder or flooring material. As observed above, area B4 is thought to have housed animals, so hay fodder might be represented in this case.

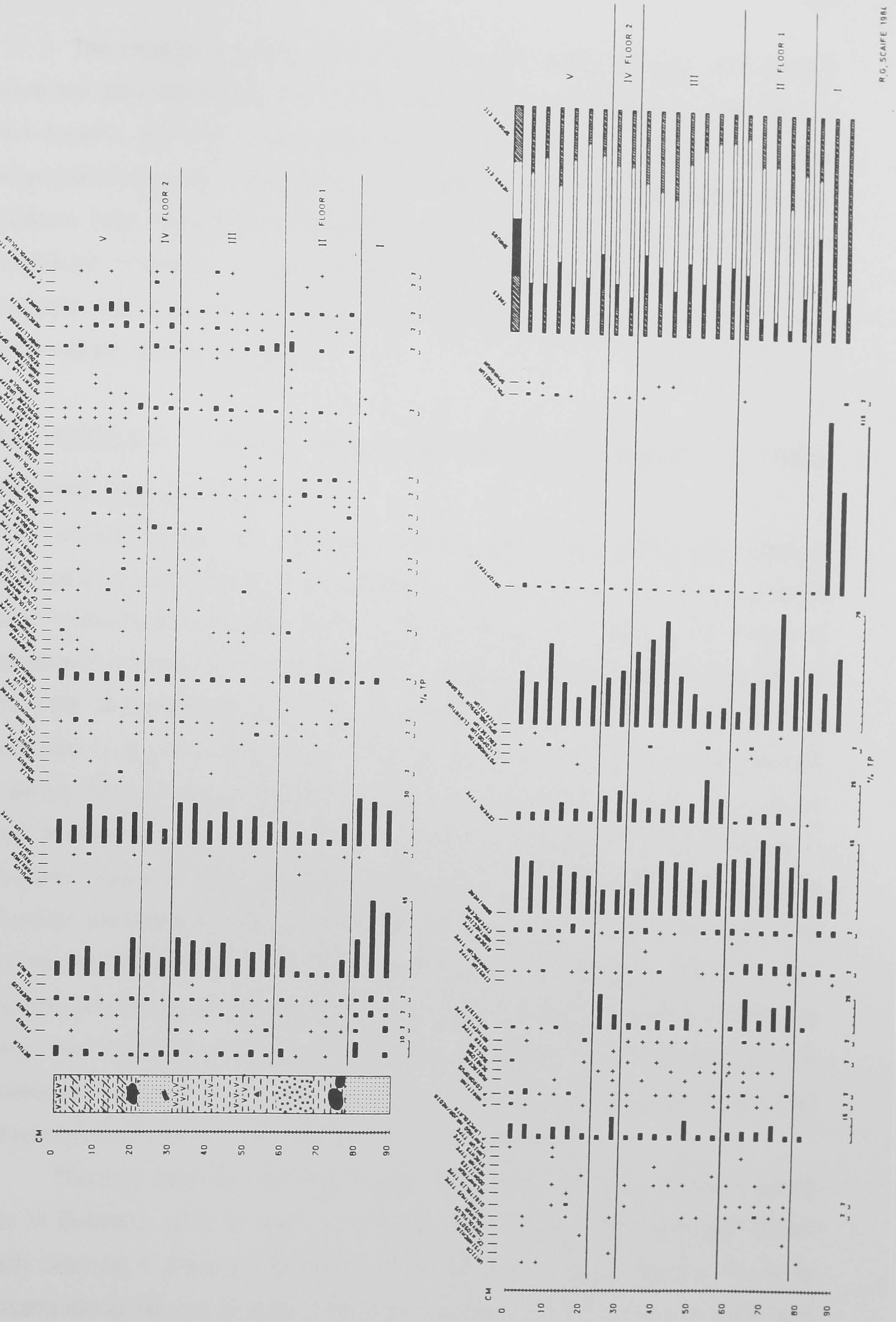


Figure 8.2. Pollen diagram from a core in area B4 (after Clapham & Scaife 1988)

The change in values of *Dryopteris* spores in the diagram from Scaife's core are also interesting. He noted extremely high initial levels at the base of the column, but then trace values only. Only a single *Dryopteris* scale was observed during this macrofossil study, and it was initially suggested that the species may have been overlooked due to the overabundance of *Pteridium aquilinum*. However, the low levels found in Clapham & Scaife's (1988) core suggest this was not the case, but merely minimal utilisation of this fern following an initially high level.

8.2. Oakbank Crannog Macrofossil Results Compared to other Wetland Sites in Britain

The unique status of Oakbank crannog in British prehistoric wetland archaeology was discussed in chapter 1. The extensive and well preserved plant macrofossil remains found on this site have substantially added to information known about the sequential progression of cereal crops in Britain in the Late Bronze/Early Iron Age by highlighting the fact that early farming practices recognised from England were also extant in Scotland. At Oakbank crannog this last refers specifically to the introduction of *Triticum spelta* which was previously unknown so early in Scotland, although had been found in England. Trade is implicated through this early occurrence, both for spelt and *Papaver somniferum*, previously thought to have been introduced to Scotland during the Roman invasion. The plant remains at Oakbank crannog have provided evidence of the agricultural practice and basic economy of this very early Iron Age site. The great number of different plant species found in situations suggestive of particular uses highlights the understanding these people had for their environment and their exploitation of it.

The only detailed plant macrofossil study from a well excavated crannog site in Scotland prior to Oakbank is Buiston (Holden 1995), although Milton Loch Crannog 1 (Piggott 1953) has been studied to a lesser degree. The early investigations did record woody species, however, and again Munro (1882) was the nearest that Scottish excavators had come to being comparable with the Swiss archaeologists. His plant macrofossil list from Lochlee crannog, identified by Dr Bayley Balfour, then the Professor of Botany at Glasgow University, produced evidence of the widespread use on the site of trees and shrubs such as *Alnus, Corylus, Betula, Quercus,* and *Salix,* and occasional artefacts of *Ulmus* and *Fraxinus*. Other plant remains included mosses, fungi, bracken, monocotyledonous tissue remains, heather stems, fern rhizomes, rolls of birch bark, and hazel nuts. Most interestingly, however, is the description of a fringe or girdle of woven *Polytrichum commune*, a moss whose robust properties have been discussed in chapter 7. Although no stratigraphic or context information exists to help explain the reasons for the incorporation of these remains individually, it is clear that they represent a similar sort of general occupation debris to that which was recorded at Oakbank. Unfortunately there does not seem to have been any attempt made to isolate or study the smaller plant remains including seeds which would have added considerably to knowledge of the agriculture and diet at the time of Lochlee crannog.

The excavation of Milton Loch 1 (Piggott 1953) was undertaken with a thoroughness approaching modern standards today, complete with reports, albeit minor ones, on the pollen and charcoal/hearth assemblages (Knox and Helbaek respectively, appendices 1 & 2 in Piggott 1953). The combined evidence of these reports is generally similar to that from Oakbank, although on a smaller scale. Small differences do exist, however, brought about by variation in the local vegetation including the presence of pollen of *Typha angustifolia* (lesser bulrush). This species has a very southerly distribution (Perring & Walters 1976), and is absent from the Oakbank locality but would have been available for the Milton Loch crannog inhabitants to exploit for thatch or flooring material.

The Milton Loch 1 assemblages show the same use of oak, alder, hazel, birch and willow that recurs frequently in crannog reports, including both Lochlee and Oakbank. Knox also observed a high proportion of herbaceous pollen, including cereal type, wild Poaceae and cultivation weeds. The combined pollen and macrofossil evidence from Oakbank found by both this author and others including Stokes (1984), Hansson (1988) and Clapham & Scaife (1988) show a similar picture. Helbaek also recorded *Persicaria* *lapathifolia* and *P. maculosa*, both of which were frequently encountered in crop assemblages at Oakbank. The combination of seed crop contaminants and the pollen evidence discussed above implies an arable and perhaps also pastoral community, such as was found at Oakbank. The abundance of hazel nuts in the hearth shows the same importance was placed on this food source as at Oakbank.

The modern re-investigation of Buiston crannog in Ayrshire was reported by Barber & Crone (1993). Munro's early excavation (Munro 1882) uncovered an extensive palisaded settlement, but left enough of the site undisturbed at the time for the latest investigation utilising modern methods and technology to yield important results. The multidisciplinary study has enabled a comprehensive understanding of the status, economy and environment of the site, with studies on plant remains including pollen, macrofossils and dendrochronology (Holden 1996).

As mentioned previously, Buiston was built in a different manner to Oakbank, with a built up mound forming the base for its settlement. It was also occupied in the Dark Ages, more than 7-800 years after Oakbank, and consequently shows differences in agricultural practice resulting from its later date. The site itself is in a hollow, drained for agricultural purposes in the 19th century, but which is still seasonally flooded today (Holden 1995). In this manner Buiston is also different to Oakbank, as the loch the former stood in was sheltered, shallow and minerotrophic. This contrasts to the deep, oligotrophic water and straight-sided, wave-exposed shoreline area of Loch Tay where Oakbank crannog was built. Consequently it is not surprising that the Buiston macrofossil assemblage contained remains of many water plants completely absent from Oakbank, including *Potamogeton* (pondweed), *Nuphar lutea* (yellow water lily), *Nymphaea alba* (white water lily), *Hippuris vulgaris* (mare's tail), *Sparganium erectum* (bur-reed), *Eleocharis multicaulis/palustris* (spike-rush) and *Elatine hydropiper* (waterwort). Holden (1995) concludes that these remains are either the result of fluctuating water levels inundating the site, or the collapse and subsequent rebuilding of parts of the structure. At Oakbank crannog very few water plant remains are thought to have come from the loch itself rather than just boggy areas in the vicinity. The include scant megaspores of *Isoetes lacustris* and statoblasts (resting stages) of two species of Bryozoa.

Much of the basal platform of Buiston was oak, a use in common with many wetland sites, and one which recognises the durability of the species. This was interspersed with boulders, turf and brushwood of hazel, birch and willow, these last combined with remains of heather to suggest collection from an open fairly acid heath landscape (Holden 1995). Holden further concludes the presence of an encroaching mesotrophic mire around the immediate margin of the loch. This compares favourably with Oakbank's loch-side mire but contrasts with the mixed alder and oak woodland around the crannog at that site. Other features at Buiston comparable to Oakbank include the abundance of mosses, wood-chips and other economically useful plant products, and gathered wild fruit. Holden (1995) recorded *Corylus avellana* nuts, and fruitstones of *Prunus padus, Sorbus, Rosa* sp, *Rubus fruticosus s.l.* and *R. idaeus*, all of which were frequent at Oakbank. He also described an abundance of six-row hulled barley and some flax. Differences in the cereal economy of Buiston to Oakbank include the presence of cultivated oats and rare bread wheat *Triticum cf aestivum,* but also the low numbers of cereal chaff and crop weeds, which suggests processing was not done on the site. The rotary querns found at Buiston (Holden 1995) indicate the final stages of food processing were done there, however, but also highlight the age differential from Oakbank, where only evidence of saddle querns was found (Dixon 1984b).

Holden suggests that the evidence of off-site processing may have resulted from a community redistribution program or tribute system, and supposes a degree of high status on the site. This proposition is made more likely by his discovery of coriander (*Coriandrum sativum*) and dill (*Anethum graveolens*), from sediments associated with wooden structures with dendrochronological dates of AD 594-620. Both these species are exotic herbs with a Roman tradition, and the period has been linked with trade routes from Ireland and the Continent. Trade is also implicated at Oakbank from the discovery of both spelt and opium poppy. It is suggested that Oakbank may show either a similar, albeit primitive, form of high status site, or that some degree of trade was more usual than might have been expected at such an early stage in history.

Wetland sites in England show a different composition and organisation to Oakbank crannog, in that they are communities built on dry 'islands' in fenland areas. The excavations of the Iron Age Flag Fen in Peterborough (Pryor 1991) showed only moderate evidence of cereal cultivation, but an abundance of bones of wild fowl, domestic animals and fish. Pryor suggests a greater reliance on meat than cultivation at that time. Interestingly, however, seeds of opium poppy were found in these deposits, and Pryor proposes the use of opium as a pain relieving medicine for malaria. Godwin (1978) describes this as a traditional cure in the fenlands, where malaria was endemic until recently.

Slightly further south in the Cambridgeshire fens van der Veen (1991) records a more agricultural economy on the Roman site of Stonea. She concludes that although this fenland area itself was not entirely suitable for agriculture, that the 'island' of Stonea, drained by the Romans' systematic canal formation, was large enough to support a number of arable settlements which grew spelt wheat and barley, with traces of bread/club wheat and emmer found too. Other crops were flax and members of the Fabaceae. Imported species included lentils and figs.

The large Iron Age settlement of Glastonbury in the Somerset Levels was constructed on land which was slightly above the surrounding swamp and shallow standing water, the level of which varied with respect to season (Bulleid 1958). Bulleid described the basal vegetation layer as reed swamp, on to which the clay mounds for constructions were put. However, Housley (1995) has re-examined the environment around the settlement and identified a wet alder fen carr below this which had been succeeded by the wet reed swamp. It was on to this *Phragmites/Typha* swamp that the wood and clay base construction for the village was deposited, having first cleared the remains of the pre-existing willow and alder carr (Housley 1995). The settlement consisted of up to 90 structures, calculated from their clay floor circles, and interpreted as houses, stables, workshops, cooking shelters, and others (Housley 1986).

The timber and brushwood mound on which the settlement was built was surrounded by a palisade, mostly of alder (Housley 1986). As observed previously, this is in keeping with the majority of British wetland sites and demonstrates the understanding of the differential properties of the various species of wood. Housley's (1995) appraisal of the Glastonbury environment at the time of the settlement has identified a mosaic of ecological conditions, with areas of oligotrophic mire near raised bogs to the west and mesotrophic to eutrophic mire with areas of standing water around the village. He compared this to Flag Fen in his doctoral thesis (Housley 1986), and in many ways this description is similar to Buiston too, although that site is a single dwelling.

The plant remains found within the peat matrix during the initial excavations by Bulleid and Grey were examined by Reid (in Bulleid 1958). Unfortunately there is no context information for these findings, so it is not possible to identify change in assemblages. Many of the plants were mire and aquatic species, concurring with the findings of Housley (1995), but since this study was from within the settlement, there were also a number of indications regarding the agricultural economy of the people. Remains of cultivated crops were found, including two and six-rowed barley, bread wheat (*Triticum aestivum*) and broad bean (*Vicia faba*). This contrasts to Oakbank, where only six-rowed barley was found, and there was no evidence of bread wheat. As observed previously, the absence of Fabaceae at Oakbank may not be real. Reid also reported some possible crop contaminant species at Glastonbury, including *Aethusa cynapium, Atriplex patula, Chenopodium* spp, *Fallopia convolvulus, Persicaria lapathifolia, Polygonum aviculare, Stellaria media* and *Vicia* sp, as well as wild fruits such as *Crataegus monogyna, Corylus avellana, Prunus spinosa, Rosa* sp, *Rubus caesius, R. fruticosus s.l.,* and *Sambucus nigra.* Many of these were also gathered for consumption at Oakbank. Unlike Oakbank, however, the presence of fruits and pollen of *Cladium, Phragmites* and *Typha* (Housley 1995) demonstrates the availability of these species for thatch at Glastonbury.

It can been shown by this comparative discussion that the plant species utilised by British prehistoric wetland communities show a number of similarities brought about by necessity, and many differences resulting from variations in their environment and their historical period.

8.3. Wetland Sites in Europe

There have been many studies on the plant remains from Neolithic and Bronze Age lake settlements of France, Italy, Germany and most especially Switzerland, both recently and in the previous century (e.g. Ammann *et al.* (1981), Bocquet *et al.* (1987), Dick (1989), Fredskild (1978), Heer (1866), Jacomet (1990), Karg (1990), Perini (1987), Ruoff (1987) and van Zeist & Casparie (1974)). The importance of plant macrofossils for identifying the economy and living conditions in these settlements has been recognised since the first excavations last century. Heer's (1866) report on plant remains from the Neolithic Swiss lakes settlements included details of the cereals, crop weeds, pot-herbs, fruit and nuts, oil plants, flavourings, fibre and dye plants, trees, mosses, ferns, fungi for kindling and natural vegetation. His invaluable observations highlighted the fact that such early settlers could conduct a fairly complex agricultural system based on both arable and pastoral agriculture. He described lax and dense eared six-rowed barley and bread wheat, along with club wheat *Triticum compactum*, distinguished from bread wheat by whole ear morphology, and small amounts of emmer and einkorn. Spelt was absent, but a small form of peas (*Pisum sativum*), millet (*Panicum miliaceum*) and foxtail bristle-grass (*Setaria italica*) were found. Heer recorded a flat cake of opium poppy seeds, and another containing seeds of a primitive, small type of flax. Both of these are remnants of secondary crops for oil and/or flavouring, and fibres too in the latter case. This crop assemblage was also found by Jacomet *et al.* (1991) in their study of similar aged lakes around the Zurich area.

Other authors mentioned above, including Ammann *et al.* (1981), Bocquet *et al.* (1987), Fredskild (1978), Jacomet (1990), Karg (1990) and van Zeist & Casparie (1974) investigated Neolithic and Bronze Age lake-side sites from France, Italy, Germany and Switzerland. There is variation in the percentage composition of individual species between these sites, depending on their age and location but the general view is one of *Triticum aestivum s.l.*, *T. monococcum* and/or *dicoccum, Hordeum vulgare, Pisum sativum, Papaver somniferum* and *Linum usitatissimum.* None of them show evidence of the millets, suggesting a preference for wheat and barley crops. The Oakbank crop assemblage shows a similar range to these continental lake settlements, but the time differential has replaced *Triticum aestivum s.l.* by *T. spelta,* and *T. dicoccum* is more prevalent. As mentioned before, the lack of Fabaceae is probably not real, and the millets would not have grown well in Scotland due to the requirement of those species for mild dry growing seasons. They are spring sown even on the continent.

Trees, gathered wild fruit and nuts, and species collected for other uses (e.g. bedding, flooring, flavourings) on the continental sites show many similarities to the Oakbank assemblage, but also differences due to the more southerly locations and the habitat range at that time of the various native species. For example, beech nuts (*Fagus sylvatica*) are recorded frequently on the continental sites, but the species had only reached Wales and Derbyshire by 1000 radiocarbon years BP (Birks 1989). Similarly grape pips (*Vitis vinifera*) and walnuts (*Juglans regia*) were recorded in the continental assemblages, but indicate traded items on British archaeological sites. *Abies* (fir) features often in continental lake dwelling sites, and at Charavines 'Les Baigneurs', Lake Paladru in France it comprised 51.4% of the total wood used, although 26 species were present (Bocquet *et al.* (1987). The high abundance of this species means it was intentionally selected, probably for the high resin content in the wood which makes it durable. At 'Les Baigneurs' *Ulmus* and *Alnus* comprised only 9.1% and 6.2% respectively, although both trees withstand waterlogging well. It is likely that the abundance of fir on that site reflects its prolific occurrence in the vicinity. This cannot be compared to Oakbank, since fir trees are introduced into Scotland, but by comparison, the low levels of the native Scottish conifer *Pinus sylvestris* at Oakbank may demonstrate the scarcity of that species in the locality compared to others.

Heer recorded dried pears, numerous crab apples (*Malus sylvestris*) and some possibly cultivated forms too at the Swiss lake sites, but none of these were found at Oakbank. However, in this case it is likely that the lack of apples at Oakbank simply reflects their absence in the immediate locality. Many of the other wild nuts and fruits in assemblages from the continental lake dwellings were similar to Oakbank, though, with acorns, hazel nuts, raspberries, strawberries, brambles, dog-roses, sloes and bird cherries. Wild species indicative of crop contamination and the environment vary according to their geographical ranges.

In conclusion, the plant remains from Oakbank crannog show several basic similarities to the continental lake settlements, especially with respect to the basic crops, including the wheats, barley, opium poppy and flax. Differences are due to the more southerly and continental locations of the latter sites, but also to the difference in their ages. It must also be stressed that all the continental sites are settlements consisting of more than one dwelling, and that they have been more extensively excavated than Oakbank. This means the chances of finding rare or unusual items such as the opium poppy seeds is lower at Oakbank than it would be at these bigger site excavations.

CHAPTER 9: CONCLUSIONS.

Oakbank crannog was a late Bronze/Early Iron Age lake dwelling which was built from free-standing piles in its earliest construction. Subsequent phases of rebuilding occurred until the structure existed as a organic mound. Boulders were used to consolidate this structure and sealed in the organic matrix below it. The plant remains in the mound are extremely well preserved and abundant. This thesis has interpreted the macrofossil evidence in an attempt to understand aspects of the local environment, economy, and agricultural practices of the inhabitants during their occupation of the dwelling.

Wood and charcoal remains from the site come from a damp mixed deciduous woodland. The extensive use of *Alnus* for construction and artefacts points to a well established alder carr fringing the loch. Undressed alder trunks formed the principal components of the dwelling and extension. The particular resilience of this species to successive wetting and drying making it a sensible and long lasting choice for building, as well as a convenient one. A further benefit of using alder is that it grows fringing the water and could be floated to the construction site without having to be dragged from a distance away. This would have greatly speeded up the building process and reduced the amount of human effort involved.

Other wood species frequently used on the site include *Quercus, Betula* and *Corylus*. Small amounts of *Ulmus, Salix, Prunus spinosa* type and Pomoideae were also found by this author. All of these are typical of a mixed oak woodland. *Quercus* piles were used extensively in the walkway, but not so frequently thereafter, whether in the dwelling or as artefacts. It is suggested that the first settlers used oak available from agricultural ground clearances for the primary construction phases, and thereafter relied on the more prolific and faster growing alder when they had reduced the available oak resources in the vicinity. This does not necessarily mean that there was no oak left, however. It suggests that either the alder was more convenient to use, or that oak trees were valued for other purposes, including acorn production for fodder or famine food.

Corylus is present on the site as abundant roundwood rods and charcoal. The age and locations of these wood fragments are evidence of wattle from walls and partitions. Some evidence exists for this use of *Betula* too, albeit in a minor capacity. The frequent hazel nut shells, roundwood rods and charcoal demonstrate the value of this species to the crannog inhabitants as a source of food, wattle and fuel. Hazel requires the light of open wood margins to flower, and these shrub layers may have been managed for this purpose. However, the collection of wood from the vicinity for fuel and other household needs may have satisfied this requirement unintentionally. There is some suggestion of coppicing of the hazel resource. As this reduces nut yield it is likely that areas were set aside for either nut or rod production.

Charcoal from alder, birch and hazel was more abundant than any other trees in this study. These species burn well and produce a good heat, with alder being favoured for smelting until recently. It is suspected that the prolific use of these three species is due to a combination of their burning qualities and availability. They all grow quickly and regenerate well compared to the slower maturing oak, elm or ash. They would be more abundantly available in the vicinity to the dwelling, due to their small size and speedy growth. Elm and ash were not frequent in the immediate vicinity, although the occasional pile is reported by Sands (1994). The value of oak has been discussed.

Cereal crops grown in the vicinity to the crannog included *Hordeum vulgare* var. *vulgare, Triticum dicoccum* and *T. spelta.* The discovery of spelt wheat on Oakbank crannog demonstrates that the introduction of this species into the crop assemblage in Scotland was far earlier than was previously expected. This in turn has implications for early trade routes from the south of the country or abroad.

The abundance of crop contaminant seeds and chaff remains indicate that at least some of this cultivation was local. It is not possible at Oakbank to determine whether this was true of both the spring and autumn sown crops as suggested by Jones (1981) and Hillman (1981), since many of the weed species found are also part of the local vegetation on any disturbed soil, and assemblages may be mixed. However, it is possible to say that crops were harvested close to the ground, as indicated by seeds of low growing contaminants. This precludes the use of cereal straw as thatch, since straw intended for this purpose cannot be threshed to release the grain. No legumes were found, but this absence may not be real. Uncarbonised legumes are seldom found on sites which have no cess pits. Also, the size and shape of the seeds means they could be hand processed, which may not have been done simultaneously with the cereals. Pod fragments may have been discarded elsewhere.

Barley formed the greatest part of the cereal crop assemblage, although this could be an over-representation due to the fact that most of the cereal remains were found as crop processing waste from fine sievings which had been added to fodder assemblages. Tail grain and some prime barley in this were possibly left to supplement the animal feed. The relative abundance of barley caryopses and wheat chaff compared to wheat caryopses in these fodder assemblages may be due to the high value placed on wheat. In this situation these grains would have been removed carefully for human consumption. No evidence for the later stages of cereal processing exists to confirm this theory, however, and very few carbonised cereal grains have been found. The subsidence in antiquity of the site and the likelihood of floor debris being removed occasionally may partly account for this.

Small scale processing of crops would have been done on an almost daily basis, since glume wheats store best in the spikelet. The macrofossil evidence suggests this was done in area A2, which is near the door for light and where occasional wind would aid removal of light chaff. It also has the added benefit of avoiding the transportation of crops through the house. The numerous and varied species of weeds contaminating the cereal crops indicate that weeding did not take place, and that crops were not harvested as ears.

Fairly large numbers of wild species with nutritive value which have been suggested previously as famine food (e.g. Helbaek 1950, 1958, Hillman 1986), were present in processing waste assemblages. These include *Bromus hordeaceus, Chenopodium album, Galeopsis* subg. *Galeopsis, Polygonum aviculare, Persicaria lapathifolia* and *P. maculosa*. The frequent occurrence of these species and others emphasises the fact that less distinction was made in antiquity between crop and weed. However, their presence in crop waste assemblages from processing and those added to fodder also implies that the crop yields at the time were sufficient to avoid reliance on this starvation fare. Consequently it could be spared for livestock.

Other crops suggested from the macrofossil assemblage include *Linum usitatissimum* and *Papaver somniferum*, although the latter is present as only a few seeds. This is the earliest discovery of this species in Scotland, and highlights early trade implications in a similar manner to spelt wheat. It could have become incorporated with fodder from naturalisation on waste land, but this is doubtful since domestication of this species has resulted in an indehiscent capsule. For this reason, and due to the large size of the capsule, it is unlikely that the seeds were crop contaminants. It is more probable that the few seeds of opium poppy reflect casual loss of a plant grown on a small 'garden' scale for flavouring, or perhaps oil. The species has shared this latter distinction with lake dwelling communities since the Swiss Neolithic sites. Cultivation for medicinal purposes may not have been possible as far north as Loch Tay. Occasional seeds of *Brassica rapa* ssp *campestris* in the matrix may also have resulted from oil production, but could simply be crop contaminants.

The flax seed and capsule remains point to the utilisation of this species for oil or medicinal purposes. Numbers of capsule fragments and seeds were found in area A2 where cereal crops were also processed. No flax fibre fragments were isolated from matrix samples, but ovicaprid bone and droppings point to the presence of sheep and goats, and wool may have been preferred, for several reasons: Flax needs careful tending as a crop since it does not compete well with weeds; The stems require retting for weeks in a water filled pit, and then processed further; Stems should be harvested before seeding to produce good fibre, and wool is also warmer, absorbent and mildly waterproof. Flax may have been grown in a 'garden' situation along with opium poppy in enough quantity to satisfy the household's need for oil, for medicinal reasons and possibly also for small amounts of low grade fibres. However, the abundance of *Urtica dioica* seeds suggest that this species could also have been gathered for its fibre. It does not need so much preparation as flax and has the added benefit of growing abundantly on enriched disturbed soils without the need for cultivation or care.

Fodder assemblages were recognised in areas C2, B4 and especially C6, along with ovicaprid droppings and other indistinguishable faeces. The fodder comprised mainly mixed hay from damp and drier lowland meadows, and some areas which were substantially wetter. The identification to species of members of the small Poaceae and the genus *Carex* have aided this distinction. Ancient meadows were very species rich, and this is demonstrated in the fodder assemblages. However, wild species from track sides and waste places may also have been added to fodder, as well as the cereal processing waste discussed above. Numbers of ovicaprid droppings in the organic matrix suggest that animals were present for short stays, perhaps milking or overnight. It is likely that any deep faecal layer resultant from longer stays would have been removed at intervals, however, and may be absent.

Analysis of the pollen from one goat dropping from 94C6S9 demonstrated the potential for a more extensive study of this kind at Oakbank. There were enough comparable types to suggest the animal had consumed food similar to the macrofossils in the surrounding matrix, including significant amounts of cereal pollen. This further confirms the suggestion that mixed hay and cereal waste was used as fodder during the autumn and winter months. Low numbers of pollen grains from early spring flowering trees implies that leafless twig foddering such as was found by Rasmussen (1993) was not likely.

Gathered wild fruits and nuts played an important role in the diet of the Oakbank inhabitants. Hazel nuts have already been mentioned, and were frequently found in the organic matrix. They would have constituted an important source of calories in the winter months, and one with the added advantage of storing easily. Once dried, *Prunus spinosa* and *P. padus* fruits also store well, and lose much of their tart flavour in this way especially if frosted first. They would have provided vitamins and flavoured an otherwise dull staple cereal broth meal. Soft fruits including *Empetrum nigrum, Fragaria vesca, Rosa* (probably *R. canina*, the dog-rose), *Rubus idaeus, R. fruticosus s.l.*

Sorbus aucuparia and Vaccinium myrtillus/vitis-idaea point to a summer collection and immediate consumption. The mixed deciduous woodland surrounding the agricultural unit is a likely source for these wild fruits. The presence of occasional fruitstones of *Rubus chamaemorus,* a rare but delicious montane species, has implications for long range gathering, perhaps during transhumance or hunting trips. This is the earliest discovery of this species in a Scottish archaeological site and demonstrates its recognition as a food plant in antiquity.

Further evidence for transhumance comes from the hay assemblages on the site. They point to gathering from mixed lowland meadows, and it is suggested that animals were taken to high summer pastures to allow the lower meadows to mature and set seed for hay. Bones of wild hunted animals such as deer have not been found on the crannog site (Dixon pers. comm.), which may suggest a greater emphasis on arable and pastoral agriculture than hunting. However, some degree of hunting is likely and cannot be excluded since bone in general is badly preserved.

Pteridium aquilinum was used primarily for thatching, bedding and flooring purposes, although *Juncus* spp and hay assemblages were also used, at least on the floor. No direct evidence exists for bedding, but it is likely that the same sorts of species that are elsewhere in abundance would have been used, with the addition of animal skins. The great abundance of bracken in all of the household contexts suggests this renewable resource was not abused, as it would not have been so prolific then as it is now. Thatch is indicated from bundles of long, straight bracken stems which are devoid of leaflets. The absence of rhizome implies that uprooting of the bracken was not practised. This would effectively remove next year's crop resource. The more primitive method of cutting the bracken at ground level in autumn (Fenton 1978) is more likely to have occurred here, and would have preserved the resource without harm.

Occasional small scale uses for many species exist, including potherbs, dyes, flavourings and medicinal reasons. Large, weft-forming mosses were also extensively used for a variety of purposes. However, none of these can be categorically proven for any individual species, and it is likely that reasons for incorporation into the matrix will change with every sample. Nevertheless it is clear that the Oakbank people had a firm understanding of their environment, maintaining a settled arable and pastoral agriculture with a healthy economy.

The local environment around the crannog consisted of mixed oak woodland on base-rich soils with alder carr communities fringing the loch, but also comprised open areas with land cleared for cereal cultivation or set aside for hay. The fertile soils supported a rich weed flora in the arable fields. Some of the hay meadows were damp, others wetter, and these may have made use of land less suited to cereals. Cultivation of winter and spring sown crops meant the inhabitants were not dependent on favourable weather, and this also spread the work load. Use of particular woods for construction and artefacts demonstrates the woodworking knowledge of these early people. Macrofossil evidence shows an efficient use of environmental resources and a degree of care to ensure their renewal. This latter includes transhumance to protect winter fodder, and may be how the rare cloudberry pips became incorporated into the matrix. This last, and the presence of bracken and heather leaves, capsules and seeds, demonstrates utilisation of upland resources from the area. Finally, the presence of spelt wheat and opium poppy indicate trading with other communities, ultimately from the south of the country or abroad.

The excavation of Oakbank crannog has provided a rare chance to utilise plant remains to investigate the economy and agricultural practices of a Late Bronze/Early Iron Age lake dwelling in Scotland. This particular study has so enlarged upon previous works as to enable sound and informed judgements to be made about the prehistoric community's degree of utilisation of numerous individual plant species, both wild and cultivated, and has elucidated many different facets of the local environment exploited by the people. The investigation has clearly distinguished areas used for food processing, animal husbandry and general occupation. It has also demonstrated long range cloudberry gathering suggesting transhumance, implied the high status of the occupants in the discovery of opium poppy and determined the roles of spelt and emmer wheat in the economy.

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