7 Animal and Plant Remains

7.1 Animal bones from Smoo Cave
by James H Barrett

This section presents an analysis of fish, mammal, bird and amphibian bone recovered during small-scale sampling of cultural deposits inside the mouth of Smoo Cave in 1992. Most of the bone derived from the upper shell midden deposits (contexts 006a/b, Phase 5). Small quantities were also recovered from other contexts of other phases, including sand or cobble beach surfaces incorporating a lower density of anthropogenic material (Pollard 1992).

7.1.1 Methodology

Twelve sediment samples of unspecified volume were collected by hand during the excavation and subsequently sieved using 1mm and 4mm mesh. Bone considered here was sorted from the >4mm fraction. A small number of hand-collected specimens (six fish, 15 mammal) retrieved from the shell midden have been combined with the sieved material.

Some specimens will have been lost during sieving (see Jones 1982; Payne 1992). This issue is of greatest significance for fish, the only assemblage of sufficient size to justify analyses of taxonomic and butchery patterns. A comparison of results regarding >4mm and <4mm sample fractions from a broadly contemporary fish assemblage at Earl's Bu, Orkney suggests that the bias introduced by using 4mm mesh may be modest (Barrett 1995). The cod family fishes which dominate northern Scottish assemblages reach *c* 0.15m within their first year of life and can grow to lengths in excess of 1.5m (Wheeler 1969; Wheeler 1978; Whitehead et al 1986a). Their bones are correspondingly large. Potential impacts of recovery procedures on species and element distributions will be considered further below.

Slightly different analytical methods have been employed for each class of bone. The fish material was analysed following procedures discussed previously (Barrett 1995). All specimens were counted, weighed and examined for taphonomic alterations such as burning, butchery and carnivore-gnawing. Forty skeletal elements were routinely identified to family, genus or species. Qualitative data regarding degree of bone fragmentation, texture and size were recorded for nine diagnostic elements (Quantification Category 1 or 'Q1' elements as defined in Barrett 1995).

All mammal and amphibian specimens were identified to the finest possible taxonomic category (with the exception of mammal ribs which were only grouped by size). This strategy was appropriate given the tiny size of the assemblage. All specimens were counted, weighed and examined for taphonomic alterations. Bone texture and portion (the latter based on the Environmental Archaeology Unit's diagnostic zone system; K Dobney, pers comm) were recorded for specimens identified to a meaningful taxonomic category. Measurements (after von den Driesch 1976) were taken on the few bones that were sufficiently intact.

Bird specimens were analysed following a strategy similar to that used for mammals and amphibians. In this case, however, no attempt was made to identify ribs or vertebrae. In all three classes, the abundance of each taxon has been tabulated by fragment count. Minimum number of individuals (MNI) estimates were not tabulated as the dataset was too small to be treated as more than a species list. Details regarding the mammal elements recovered are noted in Appendix D (archive report) for the benefit of possible future comparative work.

7.1.2 Results

Fish In total, 2115 fish specimens weighing 323.6g were recovered. The distribution among phases was very uneven, with 1694 of these specimens coming from Phase 5, the shell midden deposits (contexts 006a/b). A smaller concentration of 260 fish bones occurred in Phase 3 (context 010). All other periods yielded an insignificant number of specimens. Preservation was good, but not exceptional, in both periods.

No specimens from Phase 3 exhibited evidence of fire-alteration or butchery. Nevertheless, given the presence of anthropogenic deposits (Pollard 1992) and the virtual absence of evidence for carnivore damage, it seems likely that these bones derive from human activity rather than piscivore (eg otter, see Nicholson 1991) faeces.

Nine specimens from Phase 5 were fire-altered and the same number exhibited distinct V-shaped cut marks. Twenty-one specimens from this period exhibited crushing, which could be consistent with mastication (Wheeler & Jones 1989). Given the virtual absence of partial digestion and the tiny number of gnawed specimens, however, it seems likely that most or all of this material also represents cultural rubbish.

Phases 3 and 5 were both dominated by the cod family, *Gadidae*. Phase 5 also yielded small concentrations of flatfish and gurnard bones. All other taxa were represented by fewer than 10 specimens each.

Table 2 Fish specimens from Smoo Cave by fragment count

		Phase					Total
		1	3	4	5	6	
Shark, skate or ray	Selachii (Chondrichthyes)				2	1	3
Shark order	Pleurotremata				4		4
Ray family	Rajidae				*		*
Thornback ray	*Raja clavata*				*		*
Salmon and trout family	Salmonidae			2	2		4
Eel	*Anguilla anguilla*		1				1
Cod family	Gadidae	1	237	24	1065	75	1402
Wrasse family	Labridae				**		**
Atlantic mackerel	Scomber scombrus			2			2
Gurnard family	Triglidae				9		9
Grey gurnard?	*Eutrigla gurnardus?*			3			3
Flatfish order	Heterosomata				3		3
Halibut family	Pleuronectidae				13		13
Dab?	*Limanda limanda?*			1			1
Flounder?	*Platichthys flesus?*			1			1
Plaice?	*Pleuronectes platessa?*			11	1		12
Unidentified			23	10	578	46	657
Total		1	260	37	1694	123	2115

*Dermal denticles
**Lower pharyngeal bone

In Phase 3, saithe dominate the small cod family assemblage (Table 2). Most of these specimens derived from relatively small fish between 0.15m and 0.5m in total length. Saithe can reach lengths of *c* 1.2m (Whitehead et al 1986a) and large specimens are common finds at Late Norse (medieval) sites in northern Scotland such as Freswick Links (Jones et al 1996) and Robert's Haven in Caithness (Barrett 1995). In this region, small saithe are typically a product of shore-based or shallow-water fishing using a line or net (Fenton 1978; Baldwin 1982). While the sample size is too small to justify definitive statements, it is therefore possible that this assemblage represents inshore fishing. In the absence of evidence for fire-alteration or butchering, it is difficult to suggest whether these fish were originally intended for consumption in the cave or for transport to another settlement. It may be relevant to note that charcoal (and a charred mammal specimen) derived from this period, and that caves were used for drying fish in northern Scotland during the 19th century (Walker 1982). Too few specimens were recovered from this period to facilitate seasonal inferences based on apparent year classes in the distribution of fish size estimates (see Mellars & Wilkinson 1980; Enghoff 1986).

The gadid assemblage from Phase 5 is dominated by haddock. It is initially tempting to attribute this pattern to taphonomic factors, as haddock have extremely robust cleithra and post-temporals. It is evident, however, that other less anomalous elements from this species are similarly abundant. Haddock are bottom-dwelling fish found in depths from 30m to 300m (Whitehead et al 1986a, 687). Although unlikely to be abundant in shallow waters, they have been taken within 2km of shore in northern Scotland (in deep water to the south and west of Orkney, for example) (Goodlad 1971; Colley 1983).

Haddock grow to *c* 1m, but the majority found at Smoo were between *c* 0.3m and *c* 0.8m in total length. Most actually belong to the smaller end of this range, *c* 0.3–0.5m, and it is likely that additional small specimens were lost during sieving.

Only one other broadly contemporary assemblage from northern Scotland exhibits a substantial proportion of haddock: bone from the Late Norse deposits (perhaps 13th–14th centuries cal AD; C Batey, pers comm) of a high status domestic midden at Earl's Bu, Orkney (Barrett 1995). The size distribution is similar at both sites, perhaps suggesting that 0.3–0.8m fish were purposely selected by fishermen – either after each catch or through choice of hook size (see Owen 1994). Hooks and hand-lines were probably the primary gear for deepwater fishing in medieval Scotland (Barrett 1995).

One initial interpretation of the shell midden at Smoo Cave was that it represented a specialized location for processing haddock for storage. Medieval dried (cod family) fish production typically involved removing the cranium and anterior vertebrae at the processing site, leaving appendicular elements (such as cleithrum and post-temporals) and caudal vertebrae in the finished product (Barrett 1995). In theory it is therefore possible to recognize a fish-curing station based on the relative

Table 3 Comparison of nine (Q1) haddock cranial and 'appendicular' elements from Smoo Phase 5 and Earl's Bu

	Phase 5 (NISP)	Earl's Bu (NISP)
Cranial elements		
Articular	10	31
Dentary	7	15
Maxilla	12	22
Premaxilla	9	17
Quadrate	17	27
Parasphenoid	5	10
Vomer	6	21
Total	66	143
'Appendicular' elements		
Post-temporal	13	49
Cleithrum	31	90
Total	44	139

Table 4 Chi-square comparison of haddock cranial and 'appendicular' specimens from Smoo Phase 5 and Earl's Bu

	Cranial	'Appendicular'	Total
Phase 5			
Observed	66	44	110
Expected	58.65	51.35	
Earl's Bu			
Observed	143	139	282
Expected	150.35	131.65	
Total	209	183	392
Chi-square: 2.744			
Degrees of freedom: 1			
$P > 0.05$			

absence of appendicular elements and caudal vertebrae.

In practice, however, there is little use in considering the relative representation of vertebrae from Smoo. The proportion of tiny caudal vertebrae will have been seriously affected by recovery bias. Moreover, any interpretation of haddock butchery patterns is complicated by the anomalous preservation characteristics of the cleithrum and post-temporal. It is not surprising that they are among the most abundant haddock elements when tabulated by both fragment count and MNI.

An understanding of the anatomical breakdown of haddock elements from Phase 5 is best achieved by comparison with results from Earl's Bu (see Table 3). This assemblage has been interpreted, based on a combination of ecological, cut mark and anatomical evidence (Barrett 1995), as a consumption site to which a mixture of whole and cured fish was imported. A chi-square test of the ratio of appendicular to cranial elements suggests that there is no significant difference between the assemblages in this regard (see Table 4). Qualitative assessment of rank order lists of all identified gadid cranial and appendicular elements suggests a similar interpretation. Therefore, it is likely that haddock were not being cured in the cave for consumption elsewhere.

This interpretation is strengthened by the fact that, although both assemblages exhibit similar preservation characteristics, bones from Earl's Bu were slightly more degraded. If taphonomic biases have differentially exaggerated the proportion of robust post-temporals and cleithra at Earl's Bu, then the comparable abundance of appendicular elements at Smoo is even more notable.

Given these results, a second, alternative hypothesis requires consideration. Were some cured fish actually brought to the site for consumption? The scanty cut mark evidence could be considered to support this hypothesis. Two haddock elements were cut in a manner consistent with cured fish production. In contrast with this limited evidence, however, the abundance of haddock cranial elements indicates that many complete fish were consumed or discarded in the cave.

The interpretation of other gadid taxa from Phase 5 is more ambiguous. In no case is the sample size large enough to facilitate meaningful interpretation of relative representation of elements data. The few saithe specimens were all from relatively small fish (< 0.5m in total length). They may have been caught during a shore-based fishery and the smallest specimens could represent the gut contents of larger fish.

The few cod and ling bones were from large individuals that could have been incidental catches while haddock fishing in deep water (Whitehead et al 1986a). It is notable, however, that a few cod and ling specimens exhibited cut marks suggestive of cured fish production. These butchered bones are consistent with the residue one might expect at a processing site. It must be emphasized, however, that on the basis of present evidence any cod- or ling-processing in Smoo Cave was modest in scale.

Together, these two taxa represent only *c* 11% of the gadid assemblage from Phase 5. Moreover, all of the *Gadus* and *Molva* specimens recovered could have come from as few as six individual fish.

As discussed above, only two other taxonomic groups are represented by significant quantities in Phase 5 – flatfish and gurnards. Virtually all of the flatfish specimens belonged to the halibut family and many closely resembled plaice. It must be emphasized, however, that the reference material available was not comprehensive and that the differentiation of fragmented Pleuronectidae bones can be difficult. The flatfish specimens were all from relatively small fish, at least one of which was less than *c* 0.3m in total length. They can be caught in shallow water using a spear or seine net (Low 1813; Colley 1983). They will also take a hook, however, and may represent incidental catches while fishing for gadid taxa (Muus & Dahlstrom 1974).

A few of the 12 *Triglidae* bones were probably grey gurnard. Most, however, could only be identified to the family level. Gurnards are bottom-dwellers which occur from the shoreline to depths of over 300m (Whitehead et al 1986b). A Shetlandic fisherman informed me that they are often caught while line-fishing for cod family taxa (Leask 1993).

Birds The bird assemblage from Smoo Cave was very small. A total of 19 specimens weighing 2.5g were recovered, only seven of which were identified to family or genus. All other specimens were tiny bone fragments, ribs and vertebrae.

A single tarsometatarsus from Phase 3 was closely matched by lapwing, *Vanellus vanellus*. In the absence of comprehensive reference material, however, here it is identified as plover family. This wader could be a natural or cultural addition to the archaeological deposits.

All other identified bird bones came from Phase 5. Three crow family coracoids (from a minimum of two individuals) were probably jackdaw, *Corvus monedula*, given their small size and the absence of jays from northern Scotland (Heinzel et al 1973). Three dove or pigeon tarsometatarses (from a minimum of two individuals) matched rock dove, *Columba livia*, an identification with some support from the cave's setting on a rocky treeless coast in northern Scotland (Heinzel et al 1973). Both taxa frequent coasts and could represent natural deaths. Nevertheless, one unidentified bird specimen was charred, raising the possibility of human exploitation.

This minute sample is remarkable for the absence of all seabirds – taxa that dominate most avian assemblages from northern Scotland (Serjeantson 1988; Barrett 1995). It is tempting to suggest that no birds were purposely exploited at this unusual site. It is entirely possible, however, that other species would appear in a larger sample.

Mammals The mammal assemblage from Smoo Cave was also very small. A total of 421 specimens weighing 459.6g were recovered, but 383 of these were tiny unidentified fragments retained by sieving with a 4mm mesh. The sample size is too small to serve as anything other than a species list. Cattle and possibly red deer were found in the deposits from Phase 1. Phase 3 yielded sheep, sheep or goat and a fetal or neonatal ulna from a large ruminant, probably *Bos taurus*. Cattle, pig, sheep or goat and large ruminant specimens occurred in Phase 4.

The largest mammal assemblage derived from Phase 5. It included cattle, sheep or goat, dog or wolf, several broad ruminant categories and three wild taxa. The latter are *Muridae*, vole and stoat. The wild taxa exhibited no cut marks or fire-alteration and may represent natural death of midden colonizers. The rodents and birds found in Phase 5 may actually represent stoat kills. To the author's knowledge, the stoat has not yet been identified in other medieval assemblages from northern Scotland (see Barrett 1995).

There are insufficient data to facilitate a discussion of age at death profiles. As mentioned above, Phase 3 produced a fetal or neonatal ulna from a large ruminant (probably *Bos*). This phase also produced an unworn cattle deciduous third mandibular premolar. The limited epiphyseal fusion data are included in Appendix D (archive report).

Seventy-three of the mammal specimens were fire-altered and a few (from Phase 5) exhibited cut marks. It is probably safe to assume that meat was purposely brought to Smoo cave for consumption. It is more difficult to say whether living animals were kept in the cave for any length of time. No shed deciduous teeth were recovered.

Amphibians One toad humerus and two toad tibiofibulae were recovered from Phase 5. They are probably natural introductions to the midden deposits.

7.1.3 Conclusion

Only the shell midden (context 006, Phase 5) yielded sufficient material to justify any significant conclusions. This deposit is distinctive. It would appear that both fish and mammal flesh was consumed in

Smoo Cave during Phase 5. The paucity of carnivore damage limits the likelihood that the assemblage was collected by non-human agents (see above for exceptions to this generalization). It is conceivable that some of the fish were discarded by fisher folk when landing catches in this natural harbour, and that some weak mammals stumbled into the cave for shelter and died there. However, burned bones and cut marks strongly imply that much of the material was food waste.

There is no anatomical or butchery evidence to suggest that the dominant taxon, haddock, was being processed and cured for consumption elsewhere. A tiny number of cod and ling bones could be consistent with cured fish production. They are much too rare, however, to imply that this practice was the site's prime function. Phase 5 at Smoo is not a fish-processing midden of the type tentatively identified at the relatively nearby sites of Robert's Haven and Freswick Links (Barrett 1995).

The zooarchaeological evidence would seem to imply that the cave was actually occupied up to the medieval period – at least as a sheltered location for the preparation of hot meals. The recovery of iron rivets may imply the presence of boats which – coupled with Smoo's setting as a natural harbour – is consistent with use of the cave as a fisherman's shelter. Given this interpretation, the shell component of the assemblage may have resulted from collecting fish bait (Fenton 1992).

This discussion of Phase 5 requires an important caveat. This report has assumed hitherto that the samples are moderately representative of the shell midden as a whole. This assumption, however, could be incorrect. It is conceivable, for example, that the unusual abundance of haddock was created by sampling an area where a single catch from a rich haddock shoal had been discarded.

7.2 The fish remains from Glassknapper's Cave, Antler Cave and Wetweather Cave

by Ruby Cerón-Carrasco

7.2.1 Methodology

The fish remains from the Geodha Smoo caves were recovered mainly by sieving through a 1mm mesh, although a few elements were collected by hand during the excavations. Identification of the remains was done using modern fish bone reference collections and by reference to standard guides (Roselló-Izquierdo 1988; Watt et al 1997).

All fish remains were examined and, where possible, identified to skeletal elements and species or assigned to a higher taxonomic level, that is, family group, or ultimately classed as unidentifiable when the bones consisted of mainly broken fragments (nomenclature follows Wheeler & Jones 1989, 122–3).

Where appropriate, all major paired elements were assigned to the left or right side of the skeleton. All elements were examined for signs of butchery and burning. The colour of burnt bone was recorded to allow analysis of the nature of the burning.

Measurements were not taken on the identified elements; instead elements were classified into size categories for total body length. This was done by reference to modern specimens of known size. For the *Gadidae* group, some elements were categorized as 'very small' (< 0.15m), 'small' (0.15–0.3m), 'medium' (0.3–0.6m), 'large' (0.6–1.2m) or 'very large' (1.2–1.5m). This approach will in most cases provide a sufficiently accurate picture of the size of the species present. For the non-gadoid species, a classification as 'juvenile', 'maturing' or 'mature' was made.

Recording of the preservation of bone was based on two characteristics: texture on a scale of 1 to 5 (fresh to extremely crumbly) and erosion also on a scale of 1 to 5 (none to extreme). The sum of both was used as an indication of bone condition; fresh bone would score 2 while poorly preserved bone would score 10 (after Nicholson 1991).

7.2.2 Results

The detailed results of the analysis of the fish remains from the Geodha Smoo caves are given in the catalogue, included in the archive report.

The level of preservation of the fish bone was consistent throughout the site, in terms of fragment size and condition. Most bones were 40–70 % complete. Their condition score was generally in the range of 7–9, indicating poor to extremely poorly preserved bone. A total of 24 taxa were identified: 19 to species and five to family level. The numerous unidentifiable fragments consisted of mainly cranial fragments and tiny fragments of ribs and fin rays. These were not considered in the results tables, as they would have given a distorted image of the assemblage; they are mainly the results of post-depositional and post-excavation damage.

Glassknapper's Cave This cave was more extensively excavated and therefore produced most of the fish remains from Geodha Smoo. Glassknapper's Cave also produced the greatest variety of species (see Table 12 below), which show that those using the cave practised mixed fishing.

Fishing from rocks for young saithe and pollack would have also caught young cod and rocklings. The use of boats and hand-lines would have been required for catching mature cod, haddock, ling and torsk as well as other species such as red sea bream, gurnard, rays, dogfish, ballan wrasse and mackerel. Hand-lines might have consisted of a wooden reel, small streamlined weight, and a line of several fathoms ending in a number of hooks attached by horse hair; such hand-lines, known as 'toams', were used in the Northern Isles during the 19th and early

20th centuries (Goodlad 1971; Fenton 1978). Herring was also present. Nets were probably used for catching these, although they can occasionally be caught on line.

Element representation for the gadoid species appears to be quite even, with most elements well-represented. This rules out the possibility of Glassknapper's Cave having been used as a curing station for the production of stock fish (dried), as appendicular elements (for example, cleithra) are present in quite even numbers, as well as caudal vertebra in both large and small specimens. Appendicular elements and caudal veterbra are usually left on stock fish (Cerón-Carrasco 1994; Barrett 1997). This may be best appreciated by looking at the gadoid element representation for the three caves.

It therefore appears that the fish from Glassknapper's Cave were caught to be consumed on site and were not intended for preservation and transportation elsewhere.

This is further supported by the fact that only two elements with cut marks were recovered. One was a cleithra from a large *gadidae* from common sample Spit 13; such marks may have resulted from beheading the fish. A post-temporal from a large specimen also displayed several cut marks, which may have been produced during gutting or filleting.

Most of the samples from this assemblage also contained burnt fish bone; these were partially burnt black or grey, which would indicate the burning of domestic rubbish.

Antler Cave Due to the limited amount of material excavated at this cave (see Table 12 below), very few fish remains were recovered compared to the adjacent Glassknapper's Cave and Wetweather Cave.

Antler Cave produced a very limited number of species, mainly first- and second-year saithe and pollack, a few elements from medium-sized cod and a single element from a large individual (which was hand-collected). Also present were remains from mature herring (0.35–0.4m), ballan wrasse and a single vertebra from sandeel.

Those using the cave may have fished for young saithe and pollack using a simple line and hook, and for medium-sized to large cod using boats. The presence of mature herring may also indicate the use of boats, although nets rather than lines would have been required for this catch. However, due to the poor preservation of the sediments in this cave as a result of heavy erosion (Pollard 1996b), the remains may present quite a biased picture when compared to the other two caves. There were no signs of gnawing or other activity related to animal intrusion.

Wetweather Cave The fish remains from Wetweather Cave were covered with a limy powder. The fish bone elements recovered were mainly vertebrae from very small and small specimens of saithe and pollack, and from small gadoid species such as shore rockling and bib, although rocker, grey gurnard and eel were also present (see Table 12 below).

None of the remains showed any signs of digestion or of gnawing such as may have been incurred by other mammals, like the coastal otter (*Lutra lutra*), implying they were fished for consumption by humans. Most of the remains from young saithe and pollack and bib derived mainly from two samples – context 1/006, Slot 1, Spit 1 and context 1/006, Slot 1, Spit 3 – both midden deposits.

This assemblage represents inshore fishing probably carried out during autumn, when young saithe and pollack are most abundant and can be caught by line-fishing from rocks by the shore. Rocker and grey gurnard may also have been caught inshore, as well as eel, although this species may have been caught at burn entrances using a basket such as the cruive.

7.2.3 Conclusion

The assemblages from the Geodha Smoo caves represent different types of fishing strategies; these are best reflected by the differences in gadoid species size representation.

Glassknapper's Cave displayed more specialized fishing throughout the year than the other two caves, making full use of resources inshore and deep sea waters, although this consistently appears to have been for domestic consumption rather than for the production of stock fish.

Antler Cave may have been occupied at different times of the year. The small quantity of fish remains recovered is interpreted as the result of heavy erosion of the sediments in the cave.

Wetweather Cave reflects small-scale, domestic, inshore fishing, most probably carried out during the autumn when young pollack, and in particular saithe, are most abundant. While fishing for these may have been a priority, other species such as grey gurnard and rocker may have accidentally been caught.

In conclusion, the hypothesis that these caves were occupied at different times of the year or throughout the year is partly supported by the fishing strategies employed by their inhabitants. Nevertheless, the evidence seems to favour fishing for consumption in the caves rather than for the preservation and consumption of the fish elsewhere.

7.3 The mammal and bird bone from Glassknapper's Cave, Antler Cave and Wetweather Cave

by Catherine Smith

7.3.1 Methodology

Extensive sampling, both on site and in the laboratory, of the archaeological deposits found in Glassknapper's Cave, Antler Cave and Wetweather Cave resulted in the recovery of plentiful faunal remains. These included the bones of mammals, birds and amphibians. All samples from Antler Cave and Wetweather Cave were examined and recorded, whether recovered on site or under laboratory conditions. Samples from Glassknapper's Cave collected on site, both by hand and by sieving, were examined and the faunal component recorded fully, while approximately two-thirds of the lab samples were also subject to detailed examination. All teeth, which had previously been extracted from the column samples, were examined because these were expected to provide useful confirmation of the species present.

The level to which a particular species could be identified was somewhat hindered by the exceptionally fragmented state of the bones. Thus, although cattle and red deer can normally be separated with some confidence, the surviving fragments from the caves were in many cases too small to retain the so-called diagnostic zones which aid identification. In particular, the assemblage was dominated by splinters of the shafts of long bones while very few articular ends, which are often diagnostic of particular species, were recovered.

Although cattle have been found to be the dominant species at the majority of Scottish archaeological sites dating from the later Iron Age to the medieval period, it was clear from the initial stages of the analyses that red deer bones were present in quantities more typical of cattle. It was therefore unsafe to assume that most of the large fragments from the caves came from cattle. The criterion was therefore adopted of recording all large fragments for which the particular bone could be recognized, but the species could not be ascertained with complete confidence, as cattle/red deer. This category included scapula blade fragments, but not shaft splinters which were obviously from major long bones but where the particular long bone itself could not be diagnosed with certainty. Such long bone shaft fragments were described as 'large ungulate'. The term was also used to describe all large vertebrae and rib fragments which could have come from cattle or red deer. This category would normally include vertebrae and ribs of horse, but as no horse long bones were found on the site it may be assumed that all bones described as 'large ungulate' came from cattle or red deer.

Bones of smaller domesticated animals were not so plentiful in the caves. Although the identification of sheep and goat bones present well-known difficulties in separating the two species, no bones were found which were thought definitely to represent goats. All sheep-sized vertebrae and ribs were recorded as 'small ungulate', a description which would usually include, sheep, goat and roe deer; however, no bones of roe deer (*Capreolus capreolus*) were noted.

Intermediate mammal fragments were present in almost all of the samples but because some of these fragments were only a few millimetres in size it was not thought profitable to count them.

It should be noted that the high degree of breakage also precluded collecting the relevant data which would have allowed the minimum numbers of animals to be estimated; likewise, anatomical measurements based on complete bone lengths and dimensions of the articular ends were possible for only a few bones and, because these were almost all red deer phalanges, their usefulness in indicating the size of the animals was limited.

7.3.2 Species present

The greater part of the faunal assemblage was recovered from Glassknapper's Cave, and the bones from this cave were in a better state of preservation than in the two other caves. In Antler Cave and Wetweather Cave, the bones were covered with limy deposits, in some cases obscuring any diagnostic features which would aid identification. However, bones from Glassknapper's Cave were free from limestone encrustation and in some cases were well enough preserved to show knife cuts or other man-made marks.

The range of mammalian species present included both domesticated and wild animals (see Table 5). The domesticated livestock were represented by bones of cattle, sheep (or goat) and pig. Wild mammals of economic importance were red deer (*Cervus elaphus*) and seal species. It was unfortunately not possible to say whether the seal bones came from the grey (*Halichoerus grypus*) or the common seal (*Phoca vitulina*), as the small number of bones were all from juvenile or pup seals.

The single canid bone was a large metatarsal which, given the nature of and date of the site, may represent a wolf or merely a large dog. There was ample evidence that some of the bones recovered from the site had been gnawed by sharp-toothed carnivores, and it is not unlikely that the caves had contained an animal den at some point in their history.

Bones of small mammals were also recovered. These came from bank vole (*Clethrionomys glareolus*) from Glassknapper's Cave, and vole species, probably the field vole (*Microtus agrestis*). Unfortunately, no complete dentitions were found which would have confirmed the species. However, it is unlikely that the vole bones were the Orkney vole (*Microtus arvalis*), as this species is not found in mainland Britain. The remaining small mammal long bones from the caves probably also came from voles. In addition to the mammalian remains, four amphibian bones (probably frog, *Rana temporaria*) were also noted in the samples from Wetweather Cave. Given that there is a source of fresh water, the Allt Smoo, in close proximity to the site, as well as water dripping from the cave walls the presence of frog bones is not too surprising.

No avian remains were noted in the material from Antler Cave. Only two bones, one from Glassknapper's Cave and one from the Wetweather Cave, were from a domesticated species, the fowl

Table 5 Total numbers of mammal bones found in Glassknapper's Cave (GKC), Antler Cave (AC) and Wetweather Cave (WWC)

Species	Site GKC	AC	WWC	Total
Cattle	59	4	3	66
Red deer*	157	14	6	177
Cattle/red deer	29	1	1	31
Large ungulate (vertebrae and ribs)	140	3	3	146
Large ungulate (long bone shafts)	185	1	37	223
Sheep/goat	33	4	1	38
Pig	25		3	28
Small ungulate (vertebrae and ribs)	69		4	73
Seal sp	7		1	8
Canid			1	1
Clethrionomys glareolus (bank vole)	1			1
Microtus sp (eg field vole)		2		2
Vole sp		2	5	7
Small mammal	4	1	1	6
Amphibian			4	4
Indeterminate mammal	+++	++	+++	+++
Total	709	32	70	811

*The red deer total includes all antler fragments
+Indeterminate mammal fragments were ubiquitous in all samples and have not been counted

Gallus gallus. The majority of the bones were from wild species, mainly seabirds. These included the shag (*Phalacrocorax aristotelis*), guillemot (*Uria aalge*), razorbill (*Alca torda*), puffin (*Fratercula arctica*), herring/lesser black-back gull (*Larus agrentatus/fuscus*) and black-headed gull or kittiwake (*Larus ridibundus/Rissa tridactyla*). In addition, two bones were thought to have come from the manx shearwater (*Puffinus puffinus*), although this identification is less certain than for the other species. One bone of rock dove, or possibly its descendent the feral pigeon (*Columba livia*) and one from shelduck (*Tadorna tadorna*) were also recovered (see Table 6).

This wide range of seabirds contrasts with Smoo Cave, but it should be remembered that on that site a much smaller area was investigated and sampled.

7.3.3 *Age of animals at death*

Due to the high degree of fragmentation, little evidence of the age at which the animals were killed was available. However, two mandibles of sheep provided an estimate of age at death. One of the sheep, from Glassknapper's Cave (context 019), came from an animal of between two and three years old (based on Payne's 1973 criteria). A sheep mandible from the Antler Cave (context 040) was too fragmentary to ascertain the age with any certainty; however, the animal appears to have died between the age of three to eight years. Evidence for an older rather than a younger age is provided by a degree of dental pathology: there is recession of the alveolar bone in the area between the first molar and fourth premolar, a condition often found in older animals.

7.3.4 *Economy of the site – evidence of butchery and bone working*

Finds of clench nails and other materials in Glassknapper's Cave indicate that the caves may have served as a safe haven for the repair of boats during the Viking period. In addition, there is evidence that fish may have been processed in the caves (see Section 7.2 – The fish remains from Glassknappers Cave, Antler Cave and Wetweather Cave). Evidence from the mammal bones seems to indicate that meat from cattle, sheep, pigs, deer and seal was also prepared here. In addition, the bones, once removed from the carcasses, were utlized to make artefacts, as were the antlers of the red deer.

The evidence for meat preparation comes from the presence of parts of the carcasses associated with heavy musculature, which therefore yield relatively high quantities of meat and which in addition bear cut marks consistent with the removal of meat from the bones. For example, the presence of large numbers of rib shafts, which are unmodified apart from surface knife cuts, or from which the articular

Table 6 Total numbers of bird bones found in Glassknapper's Cave (GKC) and Wetweather Cave (WWC)

Species	Site		Total
	GKC	WWC	
?Manx shearwater:?*Puffinus puffinus*	2		2
Shag: *Phalacrocorax aristotelis*	5		5
Shag/cormorant: *Phalacrocorax* sp		1	1
Shelduck: *Tadorna tadorna*	1		1
Domestic fowl: *Gallus gallus*	1	1	2
Herring/lesser black-back gull: *Larus argentatus / fuscus*	1		1
Black-headed gull/kittiwake: *Larus ridibundus / Rissa tridactyla*	1		1
Larus sp	4		4
Guillemot: *Uria aalge*	5		5
Razorbill: *Alca torda*	1		1
Guillemot/razorbill	2		2
Puffin: *Fratercula arctica*	2		2
i0cf Puffin	2		2
Rock dove: *Columba livia*	1		1
Indeterminate bird sp	26	15	41
Total	54	17	71

'Indeterminate bird sp' includes all avian ribs, vertebrae, foot phalanges and shaft fragments

ends have been chopped, seem to point to meat production. Although ribs may be used to produce artefacts, those which survived in the caves had not been used in this way, but were discarded more or less intact, which is a good indication that they had been butchered for meat. Other bones indicating meat production are the vertebrae: evidence for carcass division at the site comes from the removal of the lateral processes of these bones. To produce vertebrae chopped in this way, the carcass would have been laid down on the floor of the cave and divided along the flanks to produce three main cuts of beef or venison, which could then be further subdivided into joints of meat. Because the vertebrae are too irregular in shape to be of use in artefact manufacture, their butchery must therefore be connected with the production of meat rather than the raw materials for bone working. Similarly, knife cuts on the premaxilla of a pig skull (layer 008, Slot 2, Spit 3), that is the snout region, also indicate meat removal, as the skull also is not suited for working by virtue of its shape.

However, there is definite evidence that long bones were deliberately chopped lengthwise (in the sagittal plane). The chopping of bones in this way was so severe that virtually no bone shafts were left intact. Articular ends (epiphyses) were also notably scarce. There are several explanations for this. It indicates that the bones had been chopped beyond recognition, or that once chopped open the spongy material of the more delicate epiphses (for example the proximal humerus) was easily destroyed under burial conditions, or that joints of meat containing the articulations were taken elsewhere to be consumed. Although this last is probably the most likely, the lack of knowledge of the whereabouts of contemporary Norse settlements in the vicinity presents the problem of just where the meat was taken.

The deliberate breakage of the long bones was almost certainly as much to do with artefact production as with marrow extraction, although there is definite archaeozoological evidence from Norse communities in Shetland and Iceland that the latter was a common occurrence (Bigelow 1993). Binford studied the butchering of caribou (known in Europe as reindeer) among the modern Nunamiut of Alaska and showed that marrow was customarily extracted, both at the settlement as well as the kill site, where the meat was initially butchered (Binford 1981, 150–1). Evidence of split long bones is therefore difficult definitely to ascribe to either practice, and may have resulted from both processes being carried out on the same bones.

There is, however, further evidence from both Glassknapper's Cave and Antler Cave that red deer antlers were certainly processed into artefacts on the site. Such evidence supports the suggestion that long bones were also being worked in the caves. The evidence from the antlers consists not only of worked offcuts, which are immediately recognizable because of their relatively large size, but also of tiny fragments recovered from the samples sieved in the laboratory. These fragments, measuring only a few millimetres across, in some cases show evidence of knife cuts. Of the column samples studied from the Glassknapper's Cave, five out of 20 samples (25%) contained antler flakes. In some cases, the slightly curved shape of the antler flakes indicates that a paring motion, perhaps with a draw knife, was used to produce them (for example, GKC column sample, Spits 23 & 27). They are reminiscent in this way of the thin curls of wood produced when a plane is used, although the form of the antler flakes was a roughly rectangular shape, of 3–4mm in thickness, with a 'pearled' outer surface consistent with comb manufacture. These offcuts possibly resulted from cutting away the outer, rough, 'pearled' surface of the antler, leaving behind a flat surface which could be polished smooth, suitable for comb side or tooth plates (for example GKC column sample, Spit 28).

None of the antler found within the caves was modified using saws. The implements were either axes, used to sever the tines from the main antler beam, or knives used to pare thin flakes from the antler surface. It is possible that adzes may also have been used: although there were no definite adze marks on any of the antlers, one burnt long bone shaft may have been butchered with an adze rather than an axe. Given that boat repair may have been going on in the immediate vicinity, it is not surprising that tools may have been used for several different jobs.

The presence of reindeer (*Rangifer tarandus*), or at least its antlers, has also to be considered. Work by Clutton-Brock & MacGregor has shown that despite a long-cherished belief in the presence of reindeer in Scotland until the early medieval period, the species became extinct some 8000 years ago (Clutton-Brock & MacGregor 1988). This is in spite of the assertion in the 13th-century *Orkneyinga Saga* that the Norse earls 'used to go over to Caithness every summer hunting red deer and reindeer in the woods there' (Palsson & Edwards 1981, 209). However, antlers are of course portable, and there is some evidence that antler combs found at a broch site of the Late Iron Age/Pictish period in Orkney may have been made from reindeer antler rather than the red deer, which were indigenous to the islands at that date (Weber 1993; Ballin Smith 1995). That said, neither Glassknapper's Cave nor Antler Cave produced reindeer antler or long bone; the large fragments of antler were definitely from the red deer. However, it should be noted that current research has yet to resolve the difficulties in distinguishing between the antlers of the two species in artefactual material.

7.3.5 Conclusion

The faunal material from the caves in the Geodha Smoo is of great interest because it provides evidence both of the strategies employed to provision Norse settlers and of the raw materials used to make everyday artefacts. Although bones of domestic animals such as cattle, sheep and pigs were present in the deposits, it is not known in what way the livestock were obtained, whether by legitimate farming or by marauding, or by some combination of the two. However, it is obvious from the assemblage that the hunting of red deer was of great importance to the people who used the caves, to provide both food and the raw antlers and bones which were processed there. Because none of the antlers appear to have been cast and deer skull fragments were also present, it would seem that they originated from animals that were killed, rather than having been collected after the animals had cast them.

Less important, but still significant to the economy of the site, was the exploitation of marine mammals such as young seals and of a number of different seabird species. Seals could be killed when they hauled up on the shore, and were the source of fats both for consumption as food and as lubrication in industrial processes. Seabirds, such as guillemot, razorbill, puffin and kittiwake, nest on coastal cliffs and it is possible that the birds found in the excavation were taken close to the caves themselves. That the bird bones were not numerous, although representing a varied range of species, perhaps indicates the difficulty in scaling the cliffs at breeding time in order to capture them. A further possibility is that the birds were indeed utilized, but that the carcasses were taken away from the site and consumed elsewhere.

7.4 Marine shells
by Ruby Cerón-Carrasco

7.4.1 Methodology

The marine shell remains from the caves in the Geodha Smoo were recovered by sieving. Apical fragments were identified to species using reference collections and standard guides (Campbell 1989). Frequency was estimated by counting shell apices for gastropods and valve umbos for bibalve species (Moreno-Nuño 1994b), but this method was only used for those Glassknapper's Cave samples which were 100% sorted.

Some of the Glassknapper's Cave's marine shell samples were not sorted, while none of the samples from Wetweather Cave and Antler Cave were sorted. This decision was taken because of the large amount of material and limited time available to analyse it. These samples were scanned and an approximate quantification has been given to give a general idea of the occurrence and importance of the different species represented.

7.4.2 Results

Smoo Cave (Table 7) The marine shell assemblage from Smoo Cave consisted of limpet (*Patella vulgata*), edible periwinkle (*Littorina littorea*) and common mussel (*Mytilus edulis*).

Patella vulgata is the most common limpet and is widely found on all rocky shores along the Scottish coast. Although its flesh is quite rubbery, when boiled it gives a milky broth which during times of hardship was commonly eaten for nourishment in some places in early modern Scotland, for example Lewis (Martin 1695). They are gathered by sharply knocking them from their toeholds on rocks, a technique that requires swiftness, accuracy and

Table 7 The marine shell representation from Smoo Cave

Samples	Species *Patella vulgata*	*Littorina littorea*	*Littorina littoralis*	*Mytilus edulis*	Crushed shell
006/1	94m + 150j + ***	494m + 28j + ***		29m + 12j + ***	****
006/2	10m + 6j + ***	58m + 13j + **	1m	**	****
006/3	89m + 180j + ***	150m + 20j + **	2m	7m + **	****
006A/1	14m + 40j + **	43m + 2j + **		2m + **	****
006A/2	101m + 303j + ****	322m + 44j + ***		11m + ***	****
008/1	13m + 5j + **	54m + 7j + **		1m + ***	****
009/1	4m + 2j + **	5m + 1j + **		**	***
010/1	20m + 8j + ***	20m + 6j + **		15m + 10j + ***	***
010/3	7m + ***	14m + 8j + **		**	***
013/1	40m + 16j + **	28m + 4j + **		22m + ***	****
020	32m + 58j + ***	53m + 4j + **+**b		** + **b	***
021	2m + **	9m + *			**
024/2	2m + *			*	**
Shell midden/lower position, Sample 1	66m + 120j + ***	133m + 20j + **		2m + **	****
Shell midden/upper position, Sample 1	36m + 88j + ***	92m + 27j + **		7m + 2j + ***	****

Key: m = mature, j = juvenile, b = burnt
Crushed shell quantification key: ** = occasional, *** = common, **** = abundant

practice (Ellis 1995). They can also be used as bait for fishing.

Littorina littorea is found on rocks, stones and seaweed on the middle and lower shore, but especially on the shore during the breeding season (September–April). It is usually gathered by hand from designated areas (Ellis 1995). Edible limpet is usually eaten boiled or steamed.

Common mussel (*Mytilus edulis*) is usually found throughout Scotland on stones and rocks in estuaries and on rocks on more exposed shores.

Only one sample (from layer 020) contained burnt shell fragments. It is likely, however, that most of the specimens recovered had been used as food, although some may have been used as fishing bait.

Very few specimens of non-edible mollusc were recovered. Flat periwinkle (*Littonina littoralis*) was present in contexts 006/2 and 006/3. These are usually found on seaweed, on bladded wrack (*Focus vesiculosus*) and on knotted wrack (*Ascophyllum nodosum*), and may have been accidentally brought onto the site along with edible periwinkle (*Littorina littorea*).

The species of marine mollusc recovered in Smoo Cave appear to have formed part of the diet of its human occupants, although they may have also been used as fish bait.

Glassknapper's Cave (Table 8) The most abundant species in this cave were the common limpet (*Patella vulgata*) and the common mussel (*Mytilus edulis*); both produced large amounts of crushed shell, much of which was burnt. Edible periwinkle (*Littorina littorea*) appears to have been equally important in this area. Also present were the whelk (*Baccium undatum*) and the common oyster (*Ostrea edulis*).

The common oyster (*Ostrea edulis*) is found from shallow water down to about 80m. Whelks (*Baccium undatum*) are found on sand and mud from shallow water down to about 100m, and are usually caught from the sea in baited pots or baskets (Ellis 1995).

Remains of edible crab (*Cancer pagurus*) and common sea urchin (*Echinus esculentus*) were also recovered from the cave. Edible crab remains from column sample Spit 18 were burnt, which indicate this was used as foodstuff. The sea urchin remains were found in Sample 8 (Slot 2, Spit 3). *Echinus esculentus* is common around the Scottish coast and has been recorded at Cnip, Lewis (Cerón-Carrasco 1997). The manner of cooking these sea creatures is by boiling or roasting on hot stones (Renfrew 1993), although they can also be eaten raw.

The species present in Glassknapper's Cave are likely to be food remains, especially those which had been burnt. Some of the species could also have been used as fishing bait, in particular the limpet, periwinkle and mussel.

Rough periwinkle (*Littorina saxatilis*) was the only non-edible species recovered at Glassknapper's Cave. This was only present in one sample and may have been accidentally collected along with *Littorina littorea* by those using the cave. Rough periwinkle is found on rocks and stones and in cracks and crevices on the upper and middle shore, where it feeds on seaweed.

Antler Cave Only one context from Antler Cave contained sufficient marine shell for detailed analyses of marine shell exploitation. A midden

Table 8 Marine molluscs from Glassknapper's Cave 100% sorted samples

	Spit																				
Species	**1**	**2**	**5**	**6**	**8**	**10**	**11**	**13**	**15**	**16**	**17**	**19**	**20**	**21**	**24**	**25**	**26**	**27**	**31**	**32**	**33**
Common limpet: *Patella vulgata*	36m + 16j *** + **b	** **b	40m + 22j ****	4m + 9j ***	12m + 8j *** + **b	3m + 6j *** + **b	3m + 5j *** + **b	13m + 18j ****	** + *b	*** + **b	*** + **b	**	** + *b	*** + *b	8m	2m + *** *b	** + *b	1m + *** **b	2m + *	4m + *** **b	1m + 1j
Flat periwinkle: *Littorina littoralis*													1m								1m
Rough periwinkle: *Littorina saxatilis*	5m									1m			1m			3m + **				4m + **b	
Edible periwinkle: *Littorina littorea*		5m + 1j	4m												1m			1m	1m	12m + ** **b	32m + 18j ****+ ***b
Whelk: *Baccium undatum*							1m														
Common cockle: *Cerastoderma edule*							*														
Common mussel: *Mytilus edulis*	31 + **** **b	*** **b	39m ****	2m + *** **b	** + *b	** + *b	7m + *** **b	***	*** + **b	*** + **b	*** + **b	*** + **b	*** + **b	*** + **b	1 + *** **b	** + **b	1m + *** **b	3m + *** **b	*** + **b	18m + *** **b	24m + *** **b
Crushed shell	****	***	****	***	***	****	****	****	****	****	***	****	***	****	***	***	****	****	***	****	****
Burnt crushed shell	**	***		**	***	***	***		**	***	**	***	**	***	**	**	***	***	**	***	***
Total weight: (g)	627	50	728.4	174	126.4	97.7	189.8	244.7	34.2	111.3	56	68.3	116.2	112.7	167.4	97.1	77.2	90.5	36.9	244.1	815

Key: m = mature, j = juvenile, b = burnt
Crushed/fragmented shell quantification key: * = occasional, ** = present, *** = common, **** = abundant

layer (035) produced large amounts of mainly common limpet (*Patella vulgata*), with some edible perwinkle (*Littorena littorea*). Crushed shells from edible mussel (*Mytulis edulis*) were also present in some of the contexts. There was no burnt shell in this cave. This and the fact that the assemblage was almost entirely represented by *Patella vulgata* from one context may suggest that these species were mainly used as fishing bait.

Wetweather Cave Common limpet (*Patella vulgata*) was the most commonly represented species in this cave, with common mussel (*Mytilus edulis*) and edible periwinkle (*Littorina littorea*) also present. There was a large quantity of broken shells, some of which were burnt. Therefore, while some specimens may have served as fishing bait, much would also have been consumed as foodstuff. Another edible species recovered at the Wetweather Cave was the common cockle (*Cerastoderma edule*), which is found buried in mud, sand or gravel on the lower shore and in estuaries.

The cave also produced the largest amount of edible crab (*Cancer pagurus*) in the Geodha, along with possible Norway lobster (cf *Nephrops norvegicus*). Both these species are widespread in the North Sea. *Cancer pagurus* inhabits substrates from the lower shore down to 100m, while *Nephrops norvegicus* is found on substrates from about 50m downwards.

Non-edible species included the periwinkle (*Littorina littoralis*) and the whelk (*Nucella lapillus*); the latter is found on rocky shores in the middle shore region, in crevices and among barnacles (on which it preys).

The large numbers of the whelk *Nucella lapillus*, most of which had been deliberately broken, are the most important aspect of the assemblage from this cave. *Nucella lapillus*, also known as *Purpura lapillus*, were used in ancient times for the production of purple dye.

Large amounts of *Nucella lapillus* were also found in association with 'kitchen middens' of *Patella vulgata* and *Littorina littorea* in Dogsbay, Connemara, West Ireland (Jackson 1919). Jackson describes how the shell of the *Nucella* had been broken; the apical whorls had been smashed, leaving the lower whorl with the mouth intact. Most of the specimens recovered at Wetweather Cave had been split from the second and third whorl and also split from the shoulder to the base, leaving the cumella intact. This would have facilitated the removal of the animal from its shell to extract the ink.

A more recent analyses involving the study of Nucella lapillus for possible dye extraction has been carried out on material from Ballyconnelly, Co Galway in Northern Ireland (McCormick et al 1996). Here the shell of the *Nucella* had been broken in a way that clearly distinguished them from other species consumed as food.

Nucella lapillus are not an edible species, and those from Wetweather Cave have not been used as fishing bait. It is clear that purple dye was being extracted from the shells recovered from the cave. According to Jackson, purple dye extracted from the *Nucella lapillus* was largely employed as Tyrean purple for dyeing parchments and vellum for biblical manuscripts, which were also adorned with gold and silver (Jackson 1919). This may certainly be the case for many of the early Christian manuscripts in Scotland, such as those produced at Iona and other ecclesiastical sites.

Wetweather Cave seems to have produced the first known archaeological evidence of purple dye extraction in Scotland for, although *Nucella lapillus* is widespread along Scottish coasts, it may not have been carefully recorded in archaeological assemblages before.

7.4.3 Conclusion

The marine shells from the Geodha Smoo indicate the use of molluscs for quite specific purposes, with each cave demonstrating a different use.

The molluscs from Glassknapper's Cave seem to have been used mainly as a source of food, as much burnt shell was recovered, probably as the result of burning domestic rubbish. Some of the species may also have been used as fishing bait.

In Antler Cave there was no evidence of burnt shells and *Patella vulgata* was the only species present in any significant numbers. It is likely that these were mainly used as fishing bait.

Wetweather Cave, on the other hand, offers the most interesting example of specialized uses of marine molluscs. Some species served as a food source, as well as possible fishing bait (limpet, periwinkle, mussel). It is also evident that the whelk *Nucella lapillus* was being used for the extraction of purple dye. The presence of this mollusc has not previously been carefully considered in assemblages from Scottish sites, and Wetweather Cave is therefore possibly the first recorded evidence of this industry in Scotland. This serves to highlight the importance of analysing all marine molluscs to consider all their possible uses at sites where they are present.

7.5 Plant remains *by Diane Alldritt*

Analysis of the environmental samples was undertaken by the author during 1996 and formed part of a larger body of research into Late Iron Age/Early Norse economies in Northern Scotland (Alldritt 2003). The archaeobotanical evidence from Geodha Smoo is presented here, together with a wider consideration of the regional importance of the site during the Norse period.

Table 9 Identified plant remains by dated phase

Geodha Smoo, Sutherland, phasing	Post AD 890–1160	Post AD 770–980	Post AD 820–1000	Undated bulk	
Sample group	Column Spit 1–2	Column Spit 3–15	Column Spit 16–33	GKC 008	GKC Other
Total sample (litres)	8	42	47	106	76
Culitvated plants					
Barley: hulled	2	4	1	4	1
Barley: naked	1	2	0	1	0
Barley: indeterminate	7	16	2	21	6
Barley: total grain	10	22	3	26	7
Barley: chaff	0	1	0	0	0
Oat	11	17	3	15	3
Oat: cultivated chaff	1	0	0	0	3
Oat: indeterminate chaff	1	10	0	0	1
Wheat	0	1	0	2	0
Wheat: indeterminate cereal	2	13	0	7	3
Weeds of cultivation	29 (5 sp)	79 (5 sp)	10 (2 sp)	16 (4 sp)	1 (1 sp)
Wild resources					
Peat	2.8g (79)	2.4g (220)	14.2g (388)	3.2g (5)	0.35g (3)
Heather stems	0.95g (65)	8.3g (475)	13.95g (733)	0.61g (31)	2.8g (118)
Seaweed	<0.05g (2)	0.1g (2)	<0.05g (1)	0.2g (10)	0.2g (9)
Charcoal (not including 'sorted indetermined')	4.8g (34)	4.3g (110)	20.4g (137)	11.85g (122)	25.95g (82)
Other remains					
Marine mollusc shell	55.7g (63)	0.2g (12)	0.1g (5)	379.4g (413)	12.35g (40)
Fish bone	22.65g (500)	15.45g (399)	0.55g (27)	80.6g (785)	5g (115)
Other bone	5.5g (4)	1.25g (8)	9.95g (239)	93.7g (36)	1.95g (52)
Industrial waste (slag)	0	0	2.4g (66)	0	26.05g (2)

7.5.1 Methodology

Extensive midden deposits, often up to 2m deep, were encountered in the Geodha Smoo, and consisted of large quantities of domestic waste, including fish bone, mammal bone, marine mollusc shell and carbonized plant remains. Glassknapper's Cave, in particular, revealed an extremely complex series of deposits, often impossible to excavate as a single context. Consequently, material from Glassknapper's Cave was both excavated and sampled as a continuous column sample. Deposits in Antler Cave formed looser, less compacted lenses of material, and hence were sampled in bulk.

A total of 48 samples from Glassknapper's Cave and a further five from Antler Cave were processed using an Ankara-style water flotation tank (French 1971), with sieve sizes of >1mm and >250microns. Samples sizes varied from two to 14 litres, with almost 319 litres of sediment processed in total. The resultant flots were sorted and plant material identified utilizing a low-powered binocular microscope typically at magnifications of 10x to 20x. Fragments of wood charcoal were examined under a high-power Zenith metallurgical microscope using magnifications from 50x to 200x. Residues from the samples were sorted and any plant material recovered for examination.

Zadenatlas der Nederlandsche Flora (Beijerinck 1947) and Botanical Macro-Remains: An Atlas for the Determination of Frequently Encountered and Ecologically Important Plant Seeds (Schoch et al 1988), together with modern reference material were consulted for identification of seeds, whilst *Anatomy of European Woods* (Schweingruber 1990) was used for charcoal. Dr J Miller identified the various macrofossils of *Carex* sp (sedges) which were recovered from the samples. Plant nomenclature used in the text follows *New Flora of the British Isles* (Stace 1997) for all vascular plants other than cereals, which follow *Domestication of Plants in the Old World* (Zohary & Hopf 2000).

7.5.2 Results

The raw results from Smoo are provided in archive tables A1, A2 and A3. The samples from Antler Cave produced no environmental remains and will not be discussed further. Samples from Glassknapper's Cave proved more enlightening and produced abundant quantities of environmental material,

Table 10 Identified cereals by context

	Column Spit 1–2	Column Spit 3–15	Column Spit 16–33	GKC 008	GKC Other
Barley: hulled	2	4	1	4	1
Barley: naked	1	2	0	1	0
Barley: indet	7	16	2	21	6
Oat	11	17	3	15	3
cf Wheat	0	1	0	2	0
Weeds of cultivation	29	79	10	16	1

including charcoal, a selection of which was submitted for radiocarbon dating. These results placed the midden accumulation firmly in the Norse period, with use of the site possibly extending into the very Early Norse period. The radiocarbon dating evidence was subsequently used to divide the midden remains into chronological groupings for ease of interpretation. Table 9 summarizes the identified remains with the aid of this chronology. Undated bulk samples have been split into two further groups and these are listed as 'GKC 008' and 'GKC Other' in Table 9 for comparative purposes.

7.5.3 Discussion

The carbonized plant remains summarized in Table 9 will firstly be discussed by general category, ie weeds, cereals, charcoal and so forth, before any wider conclusions are drawn.

Cultivated plants Carbonized cereal grain and occasional fragments of chaff were recovered from Glassknapper's Cave. Barley (mainly *Hordeum vulgare* sl) was the most commonly recovered cereal grain from the column samples, with a little six-row hulled barley (*Hordeum vulgare* var *vulgare*) also recognized. Six-row hulled barley appears to be the most typically found multi-period cereal grain on Scottish sites (Boyd 1988; Dickson & Dickson 2000, 232). Naked barley (*Hordeum vulgare* var *nudum*) was present in small amounts in the more recent midden deposits only and may have been re-introduced as a cereal crop by the Norse. This has parallels with the work on Papa Stour (Dickson 1999), where it was suggested that Norse settlers carried seed corn with them to the island, and may even have been responsible for re-introducing naked barley throughout the Northern Isles.

Table 10 clearly shows that the presence of oat as a cultivated cereal at Smoo, perhaps for animal fodder as much as for human consumption, should not be underestimated. The peaks in oat grain reflected the peaks in barley, with most cereal grain recovered from the central portion of the midden deposits (dated to AD 770–980). Cultivation of oat cereal, for grain and straw, was probably equally as important as barley, particularly with an increasing need for the production of fodder for the over-wintering of animals during the later Norse period (Alldritt 2003). Weeds of cultivation also reached a peak during the central part of the midden, although their presence throughout the deposits largely outweighs that of cereals. This strongly suggested that a large constituent of the midden consisted of dumped cereal-processing waste.

A small amount of wheat was also recovered from the central part of the midden and context 008. This may well have formed a traded product during the Norse period, certainly ethnographic records have shown importation of cereal to North-West Sutherland from Caithness during the 18th century (Bangor-Jones 2000, 66).

Weed ecology: habitat categories The weed seeds recovered from Glassknapper's Cave were divided into nine ecological groupings based upon *New Flora of the British Isles* (Stace 1997) and these are listed below. The actual numbers of weeds recovered from each phase and divided into appropriate ecological groupings are summarized in Table 11.

Sandy arable land, damp sand, ditches and dunes: *Myosotis arvensis* (field forget-me-not), *Spergula arvensis* (corn spurrey), *Ranunculus repens* (creeping buttercup).

Non-sandy arable/waste and disturbed ground: *Chenopodium album* (fat hen), *Stellaria media* (chickweed), *Polygonum aviculare* sl (knotgrass), *Galeopsis tetrahit* (common hemp-nettle).

Grassland, grassy meadows/pasture: *Prunella vulgaris* (self heal), *Plantago lanceolata* (ribwort plantain), *Carex flacca* (glaucous sedge), *Bromus* sp (bromes), *Silene* cf *vulgaris* (cf bladder campion).

Mountain pastures/rock crevices: *Alchemilla alpina* (alpine lady's-mantle).

Wetland: Aquatic, waterside and mire (base-rich): *Ranunculus flammula* (lesser spearwort), *Ranunculus scleratus* (celery-leaved buttercup), *Scirpus* (*Isolepis*) *setaceus* (bristle club-rush), *Carex viridula* ssp *oedocarpa* (yellow sedge), *Carex* cf *hostiana* (cf tawny sedge).

Moors, bogs and heath/dry heath: *Empetrum nigrum* (crowberry), *Danthonia decumbens* (heathgrass), *Erica tetralix* (cross-leaved heath), *Erica cinerea* (bell heather).

Sea cliffs, banks and woodland scrub: *Silene dioica* (red campion), *Sorbus aucuparia* (rowen), *Rosa canina* sl (dog rose).

Shingle beaches and shores: *Galium aparine* (cleavers).

Table 11 Number of weeds recovered from each phase, divided into ecological groupings

Geodha Smoo, Sutherland, phasing	**Post AD 890–1160**	**Post AD 770–980**	**Post AD 820–1000**	**Undated bulk**	**Undated bulk**
Sample group	**Column Spit 1–2**	**Column Spit 3–15**	**Column Spit 16–33**	**GKC 008**	**GKC Other**
Weed species ecology					
Sandy arable, damp sand, ditches and dunes	14 (2 sp)	34 (3 sp)	0	2 (1 sp)	0
Non-sandy arable/waste and disturbed ground	15 (3 sp)	45 (2 sp)	10 (2 sp)	14 (3 sp)	1 (1 sp)
Grassland, grassy meadows/pasture	3 (2 sp)	7 (4 sp)	1 (1 sp)	3 (3 sp)	0
Mountain pastures/rock crevices	0	0	0	1 (1 sp)	0
Wetland: Aquatic, waterside, marsh and mire (base-rich)	6 (3 sp)	7 (3 sp)	0	0	1 (1 sp)
Moors, bogs and heath/dry heath	2 (1 sp)	8 (1 sp)	2 (1 sp)	2 (1 sp)	5 (2 sp)
Sea cliffs, banks and woodland	8 (3 sp)	9 (3 sp)	1 (1 sp)	3 (1 sp)	2 (2 sp)
Shingle beaches and shores	0	4 (1 sp)	2 (1 sp)	0	0

Miscellaneous: Poaceae (grass family), Fabaceae (pea family), *Carex* sp (sedges), *Luzula*sp (wood rush), *Scirpus* sp (wood club-rushes), *Ranunculus* sp (buttercups), *Rumex* sp (docks), *Potentilla* sp (cinquefoils), *Poa* sp (meadow grasses).

Discussion of weed ecology and wild resources The majority of weeds recorded from Geodha Smoo were agricultural or waste/disturbed ground species. As shown in Table 11, a large number of the weeds present in the Glassknapper's Cave midden consisted of non-sandy arable species, and these were present throughout the dated column deposits. Sandy arable weeds only appeared in the middle portion (AD 770–980) and later. This is concurrent with the rise in cereal grain already discussed. It is possible that early local agriculture was occurring on less productive arable land – perhaps the only land available in the immediate area. However, by AD 770–980, this was supplemented by grain grown on good quality sandy agricultural soils, which may suggest this grain was imported from elsewhere.

Wetland plants and species preferring moors and drier heaths were recovered in small numbers, mostly in the mid-later parts of the midden accumulation. These probably originated from peat-cutting operations, with drier weed indicators present in the early deposits, peaking in the middle and declining toward the end. Wetter fen and bog species, however, appear mostly in the middle and later midden, perhaps suggesting increasing use of fen-like and wetter turves for fuel in the later period deposits. Abundant recovery of peat fragments and heather stems during the earliest part of the midden reinforces the idea that drier environments (and hence perhaps the best quality peatlands for fuel use) were exploited earliest. The abundance of fuel for domestic fires and the presence of charcoal and slag from metalworking in the early deposits lends weight to the argument that the caves were initially used as brief resting places for seafarers, to repair boats and gather supplies as part of longer journeys, and that this use was probably seasonal (Pollard 1996).

Woodland resource Geodha Smoo produced a large amount of wood charcoal, with types identified from a range of habitats including scrub and open woodland, mountainous areas and sheltered valleys and straths. Coniferous charcoal was found in small amounts, including *Picea* sp (spruce) which was probably driftwood gathered from the local shore (eg Dickson 1992), and *Pinus sylvestris* (Scots pine) which may have been driftwood or imported from further south on the Scottish mainland.

Other imports may have included the deciduous woods, *Ulmus* (elm) and *Quercus* (oak), present in small quantities, with oak only found in the early dated part of the midden sequence. It is possible, of course, that both these types may have been growing in the region of the caves. Oak can survive on very shallow acid soils, sometimes at over 300m, whilst *Ulmus glabra* (wych elm) inhabits limestone areas in the north and west of Britain (Stace 1997, 112, 123). However, if local, these trees were almost certainly extremely rare and found amongst scrub in sheltered areas, rather than as actual woodland. Other deciduous woods included types tolerant of bog and other wet conditions, such as *Alnus* (alder) and *Betula* (birch), and open woodland edge and scrub types such as *Corylus* (hazel) and *Salix* (willow). Overall, birch charcoal dominated the assemblage.

7.5.4 Summary and overall conclusions

The environmental material recovered from the Smoo deposits were in essence dumped midden material, containing a mixture of waste products such as cereal-processing waste, animal bone and so forth, which one might expect to have come from a nearby farm environment. Changes in the quantity of peat, charcoal and cereal grain recovered from the early dated midden layers compared to the later Norse deposits were detected during the course of the analysis. The presence of peat, charcoal and slag in the early period at Smoo may reflect temporary fires, with brief stopovers by sailors using fuel for heat and to assist with boat repairs. Subsequent (although still fairly early) Norse deposits showed increases in cereal grain and in the use of wet fen material for fuel (suggested by macrofossil remains). This may suggest a more regular Norse presence, probably involving occupation of this area by later periods. Comparison with the plant material from the excavation at nearby Sangobeg (Miller & Ramsay, forthcoming) will provide further important data for the agricultural and settlement history of this area.

Analysis of the fish bone from Smoo by Cerón-Carrasco suggested fish caught for local consumption, rather than preserving (Cerón-Carrasco 1996). Given the radiocarbon dating evidence from Smoo, which is mostly Early Norse, and combined with the archaeobotanical evidence, these data are in keeping with an economy seeking to support itself on a local scale, perhaps supplemented later by grain and other goods transported over short distances. Certainly between approximately AD 820 and 1000 at Smoo it could be suggested that transportation of cereal grain was taking place.