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Skriðuklaustur Monastery, Iceland

Animal Bones 2003-2007

Skýrslur Skriðuklaustursrannsókna XXVI

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Introduction and methodology

The animal bone assemblage described below derives from five excavation seasons (2003 – 2007) at the site of the abandoned monastery at Skriðuklaustur. A small assemblage of animal bones from the preliminary 2002 season has been described previously (Pálsdóttir 2006) and is not included here. The site was divided into excavation areas and to levels. The grid location of all finds, including that of individual or small groups of animal bones, was also recorded. Context (locus) numbers were assigned each season; in order to provide unique identifiers for database recording the context numbers have been prefixed by the excavation year to give a five figure number, thus animal bones recovered in 2003 have context numbers beginning with 3, and so on. These stratigraphic details are all recorded within the faunal database and will enable future spatial analysis of the finds. Fine-mesh sieving was not employed as standard, although samples for botanical and other environmental remains were taken. The soil matrix is however light, making excavation and collection of even very small objects comparatively easy. The good standard of recovery is illustrated by the retrieval of dog phalanges and other small elements, but it must be expected that the assemblage suffers from some collection bias.

Taxonomic identifications were made using the author's modern comparative collections. All mammal and bird fragments were identified to species and element where practicable with the following exceptions: ribs and vertebrae of the ungulates (other than axis, atlas, and sacrum) were identified only to the level of cattle/horse-sized and sheep-sized. This restriction does not apply to associated bones where ribs and vertebrae were assigned to species. Unidentified shaft and other fragments were similarly divided. Any fragments that could not be assigned even to this level have been recorded as mammalian only. Where possible the ovicaprid bones were determined to species using the methods of Boessneck (1969), Payne (1985) and Halstead & Collins (2002). Recently broken bones were joined where possible and have been counted as single specimens. Tooth eruption and wear stages of cattle and sheep mandibles were recorded following Grant (1982). Measurements mainly follow von den Driesch (1976) and are in millimetres unless otherwise stated. Withers height calculations of the domestic ungulates are based on factors recommended by von den Driesch and Boessneck (1974). Shoulder heights of dogs are calculated using the factors of Harcourt (1974) and Clark (1995). Fish remains were similarly recorded but only the major cranial and facial elements were separated to taxon. Measurements for fish are based on Morales & Rosenlund (1979). Other information recorded for each bone or group of fragments includes butchery traces, working, gnawing, burning, erosion and pathology, among others. Metrical and other data not presented in the text is retained in the digital archive.

Results

A grand total of 9868 faunal remains have been recorded; 7707 mammal bones (78.1%), 70 of birds (0.7%), 2090 fish remains (21.2%) and a crustacean claw. Summary totals of the taxa are given in Table 1.

mammals	NISP	*%*	*% of identified*
horse, *Equus caballus*	209	*2,7*	*5,3*
cattle, *Bos taurus*	634	*8,2*	*16,2*
sheep/goat, *Ovis/Capra*	2295	*29,8*	*58,6*
sheep, *Ovis aries*	587	*7,6*	*15,0*
large mammal, cattle-sized	735	*9,5*	
large mammal, sheep-sized	2184	*28,3*	
mammal, indeterminate	874	*11,3*	
whale, porpoise, Cetacea	6	*0,1*	*0,2*
seal, Phocidae	78	*1,0*	*2,0*
dog, *Canis familiaris*	55	*0,7*	*1,4*
arctic fox, *Vulpes lagopus*	5	*0,1*	*0,1*
dog family, Canidae indet.	39	*0,5*	*1,0*
cat, *Felis catus*	4	*0,1*	*0,1*
mammal, hare/cat-sized	2	*0,03*	*0,1*
Total	**7707**		
birds			
cormorant, *Phalacrocorax carbo*	1	*1,4*	*1,9*
swan, *Cygnus* sp.	30	*42,9*	*55,6*
geese, Anserinae	7	*10,0*	*13,0*
duck, mallard/domestic, *Anas platyrhynchos*	2	*2,9*	*3,7*
eagle, cf. *Haliaeetus albicilla*	1	*1,4*	*1,9*
domestic fowl, *Gallus gallus*	1	*1,4*	*1,9*
ptarmigan, *Lagopus mutus*	7	*10,0*	*13,0*
waders, Charadriidae	2	*2,9*	*3,7*
gull, Laridae indet.	1	*1,4*	*1,9*
guillemot, *Uria aalge*	2	*2,9*	*3,7*
bird, indeterminate	16	*22,9*	
Total	**70**		
fish			
shark cf. porbeagle, *Lamna nasus*	77	*3,7*	*9,9*
cod, *Gadus morhua*	488	*23,3*	*62,9*
haddock, *Melanogrammus aeglefinus*	11	*0,5*	*1,4*
ling, *Molva molva*	42	*2,0*	*5,4*
cod family, Gadidae	158	*7,6*	*20,4*
fish, indeterminate	1314	*62,9*	
Total	**2090**		
crab	1	*0,1*	

summary		
total mammals	7707	*78,1*
total birds	70	*0,7*
total fish	2090	*21,2*
crustacea	1	*0,01*
	9868	

Table 1

Taphonomy

Prior to discussion of the faunal assemblage the taphonomic factors that may affect the bones must first be taken into consideration. The constructions were mainly of turf, stone and timber; archaeological levels are relatively close to the surface and most of the finds are not deeply buried. Although many bones are in relatively good condition bone is not always well preserved. Acidic soils and freeze-thaw action in near-surface contexts are usually not conducive to good bone preservation. The condition is variable and can vary from very good with both surface and interior almost intact to so poor that the bone is almost unrecognisable. Sometimes virtually all the cancellous bone has disappeared leaving a fibrous fragile outer shell resembling tree bark. In other cases the outer, smooth, bone is spalling off the cancellous bone. It was found that sheep long bones such as tibia and metapodia are particularly prone to this damage (photo 61164 img_0315b).

61164 IMG_0315b

Smaller, compact, bones such as sheep astragali and seal metapodia are not immune but their solid construction appeared to offer more resistance. Surprisingly, neonatal bones were also less often affected, perhaps because their porous structure is more even distributed between the outer surface and the inside, reducing the stress between. Fish bones, with their inherent fibrous structure survive quite well but are often incomplete, fragile and warped, reducing the number of positive identifications and the amount of metrical data that could be obtained. Several bones are dark but are mainly stained rather than charred. Few were burnt to the level of calcination. A low level of burning has been observed in other medieval assemblages when compared to Viking ones and this probably relates to changes in the methods of meal preparation and serving. Destruction and removal by scavengers must also be taken into account, but at under 5% of NISP (number of individual specimens) the level of gnawing in this assemblage is relatively low. The taphonomic condition states for the assemblage as a whole are given in Table 2. Further taphonomic considerations concerning anatomical distribution within the species are detailed below. In general bone is well distributed across the site but with most animal bones coming from within the buildings and few from the areas outside, such as the burial ground. This analysis does not cover the 2008 excavation season and it is not known whether any of these areas contained a greater or lesser concentration of material.

	breaks	butchered	gnawed	eroded	charred	calcined	ivoried	loose teeth	Total
NISP	2384	519	482	1790	140	361	27	481	9868
percent	*24,2*	*5,3*	*4,9*	*18,1*	*1,4*	*3,7*	*0,3*	*4,9*	

Table 2

Sheep

The 2882 ovicaprid bones form 37.4% of all mammal bones and 73.6% of the bones identified to species. Bones of other species of this size are almost absent and the majority of the sheep-sized fragments will also be of sheep, 65.7% of all mammal bone when combined. Over 20% of the diagnostic bones could be positively identified as sheep, the remainder were all classed as sheep/goat with none positively identified as goat. Similarly, while several mandibles and teeth were identified as sheep, none were attributed to goat. Recent work suggests that some characteristics for sheep/goat mandible separation are not as reliable as once thought (Zeder & Pilaar 2009); for this assemblage, however, the lack of goat in the limb bones is supportive and typical of late medieval deposits in Iceland. Throughout this report the ovicaprid remains are referred to as sheep but they remain separate in the archive.

The anatomical distribution is not even but does indicate the disposal of complete carcasses, as all parts of the body are represented. Some elements are much underrepresented, however, which might imply joint selection or differential disposal strategies. In an individual sheep there are 24 of these in total, a pair of 1st, 2nd and 3rd phalanges for each foot, but there are insufficient to match the number of metapodia (the large 'canon bone' of the foot). Using zone counts to avoid the bias of fragment repetition and adjusting the figures to correct for the differences in the number of the elements in a skeleton gives an approximate MNI (minimum number of individuals). For the metatarsus this gives a value of 81.5 and for metacarpus 77; in contrast the values for the phalanges are 31.8 for phalanx 1, 19.2 for phalanx 2 and just 7 for phalanx 3 (Table 3). This inequality is typical of most assemblages and can be mainly attributed to taphonomic loss and/or recovery bias.

Element	S/G	Sheep	**total NISP**	MNI s/g adjusted	MNI she adjusted	**total MNI**
horn and horncore	1	19	**20**	0,5	4	**4,5**
skull	76	31	**107**	10	15,5	**25,5**
skull fragment	4		**4**			
hyoid	4		**4**			
maxilla	103	1	**104**	45	0,5	**45,5**
mandible	114	40	**154**	65	19,5	**84,5**
mandibular tooth group	1		**1**			
lower premolar	3		**3**			
lower premolar 4	6		**6**			
lower deciduous premolar	1		**1**			
lower deciduous premolar 4	2	12	**14**			
lower molar	67		**67**			
lower molar 2	2		**2**			
lower molar 3	32		**32**			
lower incisor	51		**51**			
lower deciduous incisor	11		**11**			
maxillary tooth group	1		**1**			
upper premolar	21		**21**			
upper deciduous premolar	12		**12**			
upper molar	76		**76**			
upper molar 3	24		**24**			
tooth frag	17		**17**			
humerus	112	55	**167**	38,5	27	**65,5**
radius	155	31	**186**	35	12,5	**47,5**
ulna	49	7	**56**	15,5	3	**18,5**
scapula	50	26	**76**	19,5	12,5	**32,0**
pelvis	125	2	**127**	49,5	1	**50,5**
sacrum	11		**11**			
femur	123	14	**137**	23,5	7	**30,5**
tibia	223	1	**224**	47	0,5	**47,5**
fibula	6	1	**7**			
patella	15		**15**			
metacarpus	169	48	**217**	53	24	**77,0**
carpal	65		**65**			
metatarsus	208	39	**247**	62,5	19	**81,5**
astragalus	74	79	**153**	35,5	39	**74,5**

calcaneum	31	33	**64**	15	16,5	**31,5**
cuboid/centroquartal	32		**32**			
tarsal	10		**10**			
sesamoid	4	6	**10**			
metapodial	43		**43**			
phalanx 1	62	77	**139**	12,8	19	**31,8**
phalanx 2	36	41	**77**	9	10,2	**19,2**
phalanx 3	22	8	**30**	5	2	**7**
phalanx not assigned	1		**1**			
atlas	18	7	**25**	8	3	**11**
axis	17	9	**26**	8,5	4,5	**13**
cervical vertebra	2		**2**			
cervical vertebra 3	1		**1**			
cervical vertebra 4	1		**1**			
lumbar vertebra 7	1		**1**			
total nisp	2295	587	**2882**			

Table 3

Comparison of the sheep phalanges with the much larger ones of cattle shows that the cattle phalanges were recovered in almost equal numbers whereas there are far fewer 2nd and 3rd sheep phalanges compared with the number of 1st phalanges, which are larger (Table 4).

Element	cattle	%	sheep	%
Phalanx 1	33	***36,3***	139	***56,5***
Phalanx 2	31	***34,1***	77	***31,3***
Phalanx 3	27	***29,7***	30	***12,2***
total	91		246	

Table 4

A further test can be used on tibia; in this case use of the same element in calculations avoids the potential problem of differential disposal of elements (toes may have been cut off and thrown away separately from the rest of the leg). The proximal epiphysis fuses much later than the distal and the bone at this end is also of a less compact nature than the distal end, which latter is therefore expected to survive better and be more easily recognised. In this assemblage there are no complete tibiae at all, there are 24 specimens that include only the proximal epiphysis but 73 that include the distal epiphysis. Almost all of the distal tibiae also had the majority of the shaft including the nutrient foramen. A further 52 specimens are of the shaft only (fragments without the foramen are not included). Other elements have similar biases and the inequalities of the element distribution, therefore, appears to be one of attrition and collection rather than indicating selection. The effect on the epiphysial fusion data must also be taken into account when considering the age representation.

Distribution across the site is relatively even with sheep bones being found in all of the main areas of bone deposition and forming 35.7% of the mammal bones. Apart from the smallest samples, which have inherent bias, most areas have between 30 – 40% sheep bones in the mammal component (Table 5). A few areas have higher proportions of sheep, for example area N (the church) with 49.2% and area H (the refectory) with 45.4. A high level in the refectory area is perhaps to be expected, with small bones being trodden into the floor, the number inside the church is less easy to understand. Examination of the element proportions shows that there is a very high number of phalanges (57) in these 159 bones, particularly the first phalanx (33). None of these have any evidence of working, or polish from use as game pieces, and the reason for this concentration is unknown.

area	none	A	B	C	D	E	F	G	G/D	H	I	J	J/G	K	K/G	L	M	N	O	P	Q	R	R/U	S	T	U	V	Total
sheep/goat	39	1	4	102	32	37	70	47	1	261	343	60	1	55	12	271	49	209	303	89	325	44	0	80	58	30	159	**2682**
sheep-sized	26	0	0	127	40	32	28	31	3	119	279	50	1	28	4	270	34	91	328	46	381	27	0	60	38	14	127	**2184**
total mammals	**93**	**1**	**11**	**336**	**117**	**113**	**162**	**110**	**6**	**575**	**916**	**169**	**4**	**140**	**29**	**849**	**135**	**425**	**1014**	**189**	**1128**	**114**	**3**	**214**	**126**	**60**	**468**	**7507**
sheep/goat % of mammals	*41,9*	*100*	*36,4*	*30,4*	*27,4*	*32,7*	*43,2*	*42,7*	*16,7*	*45,4*	*37,4*	*35,5*	*25,0*	*39,3*	*41,4*	*31,9*	*36,3*	*49,2*	*29,9*	*47,1*	*28,8*	*38,6*	*0*	*37,4*	*46,0*	*50,0*	*34,0*	*35,7*
sheep-sized % of mammals	*28,0*	*0,0*	*0,0*	*37,8*	*34,2*	*28,3*	*17,3*	*28,2*	*50,0*	*20,7*	*30,5*	*29,6*	*25,0*	*20,0*	*13,8*	*31,8*	*25,2*	*21,4*	*32,3*	*24,3*	*33,8*	*23,7*	*0,0*	*28,0*	*30,2*	*23,3*	*27,1*	*29,1*
total %	*69,9*	*100*	*36,4*	*68,2*	*61,6*	*61,0*	*60,5*	*70,9*	*66,7*	*66,1*	*67,9*	*65,1*	*50,0*	*59,3*	*55,2*	*63,7*	*61,5*	*70,6*	*62,2*	*71,4*	*62,6*	*62,3*	*0*	*65,4*	*76,2*	*73,3*	*61,1*	*64,8*

Table 5

withers height estimates in metres	Total n	max. wht	min. wht	mean wht	std. dev.	co. var.
Skriðuklaustur all	68	0,77	0,51	0,67	0,046	6,9
metacarpii	31	0,77	0,59	0,67	0,041	6,1
metatarsi	34	0,75	0,59	0,67	0,041	6,1
Sveigakot AU 3	28	0,70	0,57	0,63		
(metacarpii)	24	0,70	0,56	0,60		
(metatarsi)						
Hofstaðir II-III	21	0,69	0,54	0,60		
(metatarsi)						

Table 6

Measurements were taken on 459 of the sheep bones, 15.9%. Excepting the metapodia, complete long bones were rare and estimates of withers heights are almost exclusively from the metapodia (Table 6). These are very close to the measurements of recent Icelandic sheep and slightly larger than the 11th century ones from Sveigkot and Hofstaðir (McGovern et al 2009). The differences are extremely small but it is possible that this indicates that the animals at 15th – 16th century Skriðuklaustur were already improved to the size of the modern stock. Apart from the metapodia, measurements are mainly of the other early fusing bone parts such as distal tibia, distal humerus and distal scapula. A summary of the most common are given in Table 7.

	scapula	**humerus**	**tibia**	**calcaneus**	**astragalus**
measurement (mm)	Glp	BT	Bd	GL	GLl
MAX	**41,8**	**35,3**	**31,1**	**67,1**	**39,0**
MIN	**29,4**	**24,9**	**23,5**	**49,2**	**26,2**
N	**21**	**63**	**54**	**34**	**76**
MEAN	**36,5**	**29,8**	**27,5**	**60,1**	**29,4**
SD	***2,9***	***2,2***	***1,7***	***4,2***	***1,8***
Co. Var.	***7,9***	***7,4***	***6,2***	***7***	***6,1***

Table 7

The measurements form a tight group with little variation, suggesting a single type of stock, as expected. Sex information is very limited but plots of the metapodial proportions suggest a main grouping, possibly divided into two and a very small number of larger animals (fig. 1 a,b,c,d).

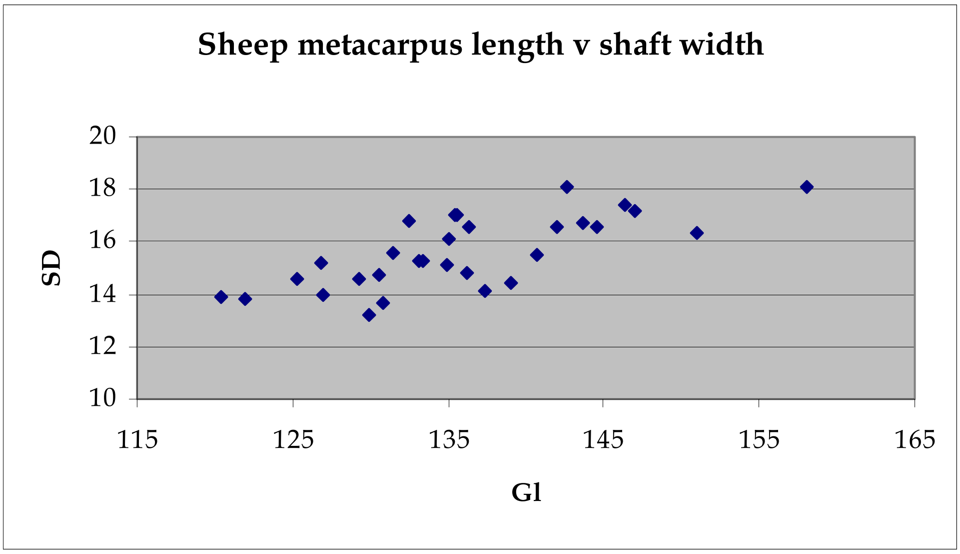

Figure 1a

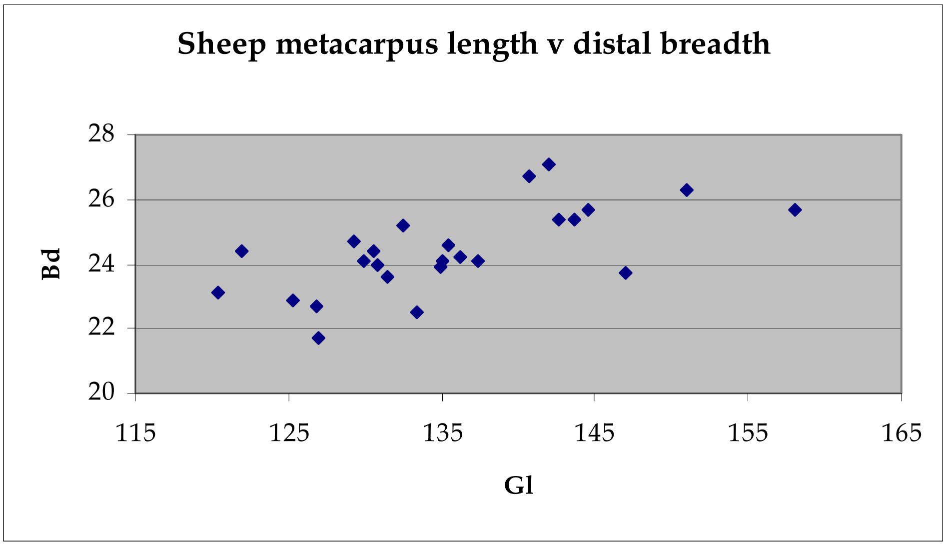

Figure 1b

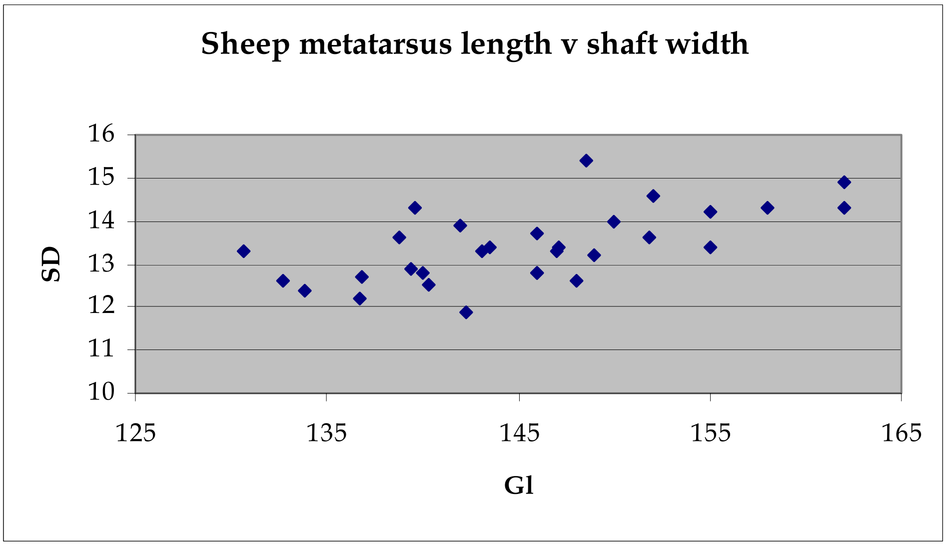

Figure 1c

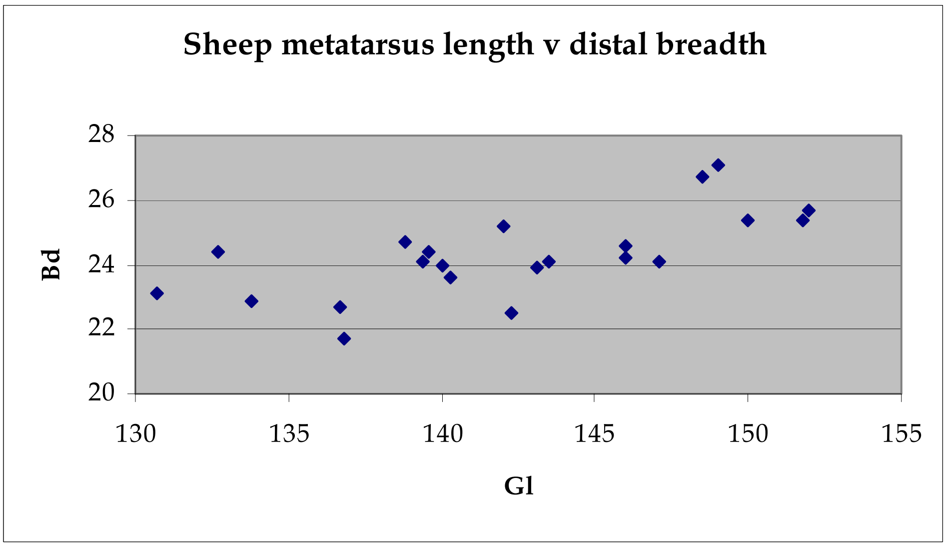

Figure 1d

If the main group does indeed originate from two overlapping groups this suggests that the smaller bones are from females, the larger ones probably representing wethers. The few much larger (comparatively) bones are likely to be of rams. It must be stressed, however, that the sample size is relatively small and the differences between the groups are not great. The few horn cores (18) in the assemblage include six identified as male and only one as female. It is possible that some females will have been hornless but also it should be noted that most of the horn cores showed evidence of working and, therefore, those of males would be deliberately selected for their larger size. There are more pelves present and for these the probable sex ratio is almost equal.

Aging information is available from mandibular tooth eruption and wear, and from the epiphysial fusion states. A few bones are present that do not always have intact epiphysial ends but compare in size and porosity with neonatal or foetal lambs. There is a single mandible fragment of a neonate, without teeth, and no loose teeth of very young animals. These bones may be underrepresented because of their small size and other taphonomic factors but, in any case, it is clear that the remains of very young lambs are negligible. There are also very few mandibles and teeth of older lambs, but noticeable peaks around stages 3 and 4 (2^{nd} molar not in wear and 3^{rd} molar not in wear, Table 8 and fig.).

Stage	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*total*
No of mandibles	2	5	21	14	8	12	13	**75**
(no. estimated)		1	6	6	5	3	5	**26**

Table 8

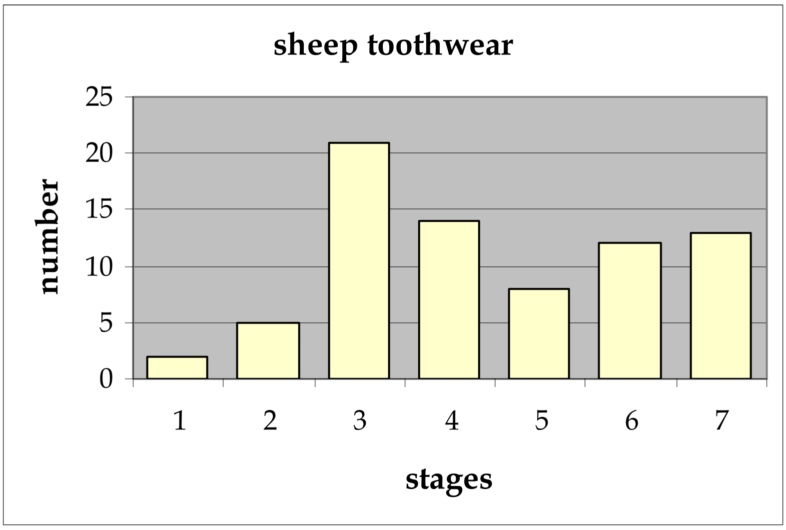

Figure with table 8

Depending on the source of comparative data, this is approximately 6 - 12 months and 12 to 18 months old (see Zeder 2002 figs.16 and 32). There is a small but clear peak at the next stage, presumably animals of the next year group, followed by larger peaks of mature or old animals. This age profile would probably indicate a dual purpose flock with prime meat production important but perhaps secondary to milk and wool. Surplus first year male lambs could be culled after a first wool cut with some kept on as wethers for another year or more. Ewes can be productive for many years but might be culled when barren or severely 'broken mouthed'. This condition was often seen at Sveigakot but similar pathology concerning the 4th premolar/1st molar area was recorded in only three examples at Skriðuklaustur (photo 51050 img_0439b).

51050 IMG_0439b

Data from epiphysial fusion (using Zeder's 2002 revised sequence) appears to show three distinct culling groups (Table 9); bones from the first three classes are almost all fused, implying that the animals survived beyond the first season. The next group of bones (D) has just over 31% of unfused epiphyses, indicating that these animals had been culled between 18-30 months. The final group, which fuse after 30 months, contains roughly equal fused and unfused bones. This grouping does not quite match the timing of the tooth eruption and wear sequence, as the first major cull appears to be later and not after the first season. Fusion of castrates is likely to be slower than in ewes and rams, which might account for some late values. Taphonomy might also have affected the bones more than the teeth; the bone structure of unfused epiphysial ends is spongy and, even if not damaged by chemical attrition, is more likely to be physically eroded and is also preferentially gnawed by dogs. The aging of bones and teeth does not give precise ages, only an approximate age and sequence; in this case the teeth and fusion agree in general sequence but not in the timing. Iceland is well within the Arctic Circle and it must be assumed that winter fodder supply would put pressure on the number of animals supported through the winter; culling of surplus stock at the end of the summer/autumn would seem a sensible regime to follow. Whether this mainly occurred in the first or the second year is unclear from this data.

group	element	epiphysial state NISP		approx. age at fusion in months	survival percentages	
		fused	unfused		fused	unfused
group A	proximal radius	70	3	0-6 month	*95,9*	*4,1*
group B	distal scapula	35	1	6-12 months	*95,4*	*4,6*
	pelvis acetabulum	89	8			
	distal humerus	105	2			
group C	proximal phalanx	172	19	12-18 months	*90,1*	*9,9*
group D	distal metapodial	160	93	18-30 months	*68,4*	*31,6*
	distal tibia	82	19			
group E	proximal calcaneus	38	14			
	femur	28	53	30-48 months	*51,5*	*48,5*
	proximal tibia	16	20			
	distal radius	30	25			
	ulna	10	3			
group F	proximal humerus	8	8	48+	*50,0*	*50,0*
	totals	765	257			

Table 9

Butchery evidence on the sheep bones is varied. Just over 12% of the sheep bones have visible butchery marks; more are likely to have been present but have been obscured by attrition, gnawing and other damage (Table 10). There are knife marks on some elements, mainly associated with disarticulation, such as those on the astragali indicating where the foot was cut from the hind leg. Most butchery marks are cuts or chops made with a heavy blade such as a cleaver or axe. The humeri and femora are often chopped across mid-shaft, sometimes there is no blade mark but the spiral fractures often seen in the same area are probably from hitting with the implement. Sheep-sized vertebrae are mainly chopped across, dividing the spine into smaller pieces. Some vertebrae have lateral or sub-axial chopping showing where the carcase was divided into sides. The few sheep skulls found often showed evidence of axial splitting to access the brain; in Iceland the traditional dish, Svið, is of the split halves roasted over fire but only two of the 16 found split had visible charring (photo 72202 img_0353b).

butchery by anatomy	
horn core	6
skull	22
atlas	1
axis	2
mandible	4
scapula	2
humerus	61
radius	25
pelvis	7
sacrum	1
femur	32
tibia	35
astragalus	19
calcaneum	1
cuboid	1
metacarpus	60
metatarsus	77
phalanx 1	1
phalanx 2	1
	358

butchery by type	
axially split skull	16
knife cuts	34
chops	65
spiral break	105
mid break	20
proximal perforated metacarpus	25
distally perforated metacarpus	5
proximal perforated metatarsus	33
distally perforated metatarsus	10
other types	45
	358

Table 10

72202 IMG_0353b

A notable aspect of the assemblage is the number of perforated metapodia. The common practice of piercing sheep metapodia to access the marrow appears in Shetland and the Faroe islands as well as in post-11th century Iceland (for example Bigelow 1984). The peculiarity in this assemblage, already noted by Pálsdóttir (2006) in the preliminary material, is that the majority are mono-perforated through the proximal articulation only (photos 51088 img_0432b and 0433b) rather than the standard bi-perforation with an additional hole at the back of the distal end (photos 40407 img_0401b and 0400b). It has been suggested that perforating the metapodia in this way leaves the bone intact for tool use. Several metapodia have indeed been worked (see worked bone section below) but not all of these were perforated at all.

51088 IMG_0432b

51088 IMG_0433b

40407 IMG_0401b

40407 IMG_0400b

The health of the animals, at least from the bone evidence, appears to be quite good. Apart from the few oral pathologies already noted, there is little evidence of severe illness but there are some indications of traumas and joint arthropathies. One metatarsus is swollen and bent at the distal end and another has much extra growth at the proximal end, probably in response to an infection. Several distal humeri and proximal radii have bony extensions of the ligaments; this is sometimes referred to as 'penning elbow' but as it occurs in the North Ronaldshay sheep, which live unpenned on the beaches, it is perhaps more likely to be an age-related joint stress condition. Several of the sheep-sized ribs have evidence of healed fractures, perhaps another indication of slips and falls on rocky or icy ground.

Cattle

Remains of cattle are the second most frequent taxon, but at 635 specimens are much less common than those of sheep. Disregarding values from the smaller (and therefore possibly biased) samples the proportion of cattle to sheep is similar in most areas of the site. The average amount of cattle is just over 18% of the cattle/sheep total (Table 11). A few areas have different proportions, notably Area N, which has few cattle remains (only 12) in comparison with those of sheep. This area is part of the church and would not be expected to be used for disposal of large remains, excepting following disuse of the building. Closer examination of the faunal assemblage from this area has several unusual aspects and it is the sheep foot bones that are at a high level.

	cattle	sheep		*% of cattle*
Area	NISP	NISP	**total**	
none	10	39	**49**	***20,4***
A		1	**1**	***0***
B	1	4	**5**	***20,0***
C	26	102	**128**	***20,3***
D	9	32	**41**	***22,0***
E	7	37	**44**	***15,9***
F	20	70	**90**	***22,2***
G	4	47	**51**	***7,8***
G/D		1	**1**	***0***
H	65	261	**326**	***19,9***
I	91	343	**434**	***21,0***
J	8	60	**68**	***11,8***
J/G		1	**1**	***0***
K	13	55	**68**	***19,1***
K/G		12	**12**	***0***
L	40	271	**311**	***12,9***
M	11	49	**60**	***18,3***
N	12	209	**221**	***5,4***
O	71	303	**374**	***19,0***
P	10	89	**99**	***10,1***
Q	160	525	**685**	***23,4***
R	2	44	**46**	***4,3***
S	23	80	**103**	***22,3***
T	9	58	**67**	***13,4***
U	1	30	**31**	***3,2***
V	41	159	**200**	***20,5***
Total	**634**	**2882**	**3516**	
	18	***82***	**(ratio 1:4)**	

Table 11

All elements of the cattle skeleton are present, but with some better represented than others. There is also a difference in representation between bones of neonates and those of the adult and sub-adult animals (Table 12). The smaller elements are not as well represented from the neonates, this is to be expected as they are more likely to be eaten by dogs, dissolved in the soil or missed in excavation. There is an apparent bias in favour of forelimb over hind limb for the neonates but there are bones from the hindfoot. It is possible that femoral fragments from very young individuals were less easily recognisable than the humerus and were more often recorded only as indeterminate.

	neonatal	%	juv/adult	%	Total	%
body area						
head & neck	33	*35,9*	102	*18,8*	135	*21,3*
teeth	1	*1,1*	75	*13,8*	76	*12,0*
shoulder	5	*5,4*	20	*3,7*	25	*3,9*
pelvis	7	*7,6*	17	*3,1*	24	*3,8*
foreleg	15	*16,3*	61	*11,3*	76	*12,0*
hindleg	8	*8,7*	50	*9,2*	58	*9,1*
patella and fibula	0	*0,0*	7	*1,3*	7	*1,1*
feet	23	*25,0*	209	*38,6*	232	*36,6*
other	0	*0,0*	1	*0,2*	1	*0,2*
Total NISP	92	*14,5*	542	*85,5*	634	

Table 12

Ageing data from toothwear and eruption sequence is very limited; very few mandibles with teeth are present. There are, however, several (at least 12) mandibles from neonatal calves; these have no permanent dentition in wear but the 1st molar can be seen developing inside the mandible (photo 51646 img_440b).

51646 IMG_0440b

The deciduous 4th premolar is present and in light wear in most of these mandibles, indicating that they had not been killed or died immediately after birth but had lived for some weeks (data taken from Grigson 1982). The few mandible fragments from older animals are mainly from adults with full permanent dentition. Where it is present these usually have the final, 3rd molar, in full wear and very worn in some cases. The ageing data from epiphysial fusion is more frequent but is likely to suffer from taphonomic bias. Excluding all the neonatal bones the remaining specimens will cover animals from 2-3 months upwards. Epiphysial fusion occurs at different stages for different elements, thus the glenoid of the scapula has fused to the main blade before the animal is a year old, the distal tibia at around two years, but the proximal epiphysis of the tibia does not fuse until the animal is around four years old. Dividing the data into approximate groups of similar fusion stage can thus be used as an indicator of when the animals were killed (Table 13).

	element	epiphysial state NISP		approximate age at fusion	survival percentages	
		fused	unfused		fused	unfused
group 1	distal scapula	10	1	group 1	*88,9*	*11,1*
	pelvis acetabulum	6	1	7-10 months		
group 2	proximal radius	10	2			
	distal humerus	8	1	group 2	*94,7*	*5,3*
	proximal phalanx	53	1	12-18 months		
group 3	distal metapodial	16	4	group 3	*82,1*	*17,9*
	distal tibia	7	1	24-36 months		
group 4	femur	5	11			
	proximal tibia	7	3	group 4	*40,7*	*59,3*
	proximal calcaneus	3	9	42-48 months		
	distal radius	5	6			
	proximal humerus	3	2			
	ulna	1	4			
	totals	134	46			

Table 13

Most of the specimens from the first three fusion groups have fused epiphyses indicating that the bones found are of adult animals. Fewer specimens from the final fusion group are fused. The combined aging data appears to indicate three death age groups; neonatal calves culled soon after birth, a second group between 3-4 years, and animals dying or being killed at a greater age. There are also a few animals representing deaths or culls spread between all ages. Of course, it is possible that other cattle remains were disposed of away from the excavation site. Assuming this collection is representative, it perhaps indicates a dual purpose focus of use; a dairy economy with culling of surplus calves and old or infirm/infertile cows, but also with some culling of prime, or near-prime, animals. These might include bulls or castrates. Indications of sex are unfortunately very few. The proportions of the metapodia can indicate sex but only one complete metacarpus was found, this one is broad and probably represents a male. Two of the pelves are probably of cows. One of these has some eburnation (polishing) inside the acetabular cup, a condition often associated with age-related arthritis (photo 50729 img_0425b).

50729 IMG_0425b

A similar arthropathy can be seen on a femoral head; this has extreme eburnation and part of the caput has been completely worn away, the corresponding acetabulum would have been similarly affected but was not found (photo 71544 img_0329b).

71544 IMG_0329b

Other abnormal bones are rare but include a scapula with some new growth and porosity around the distal articulation, two cuboid tarsals with extra bone growth (one with the small tarsal fused on). A maxilla has some lingual pitting and exostosis and a loose upper molar is unevenly worn – suggesting that the corresponding lower molar was missing. Amongst the cattle-sized bones a rib appears to show a healed break and a sacral vertebra has the distal epiphysis at an angle.

Few of the cattle bones are both complete and fused, which restricts the amount of metric information. Just two limb bones offer estimates of withers height, a radius with a calculated height of 1.187 m and a metacarpus from a probable male at 1.121 m. The two horncores that could be measured are not large, with basal minimum diameters of 38 and 43 mm. These are probably of cows (see McGovern et al 2009 p80). All of the measurements suggest the small cattle typical of Icelandic and North Atlantic assemblages. A selection of the most commonly available measurements is given in Table 14. These are mainly close in value with a small number of distinctly larger values; suggesting mostly cows with a few males.

	humerus	scapula	tibia	astragalus	metacarpus	metatarsus
	BT	**GLP**	**Bd**	**GLl**	**Bd**	**Bd**
	62,0	58,9	54,2	57,6	54,6	49,8
	62,8	65,5	55,5	58,3	55,5	50,1
	66,7	66,4	56,5	59,2	57,1	50,2
	69,8	68,9	58,7	61,7	63,4	54,7
		76,6		63,6	64,1	58,3
						61,5
Maximum	***69,8***	***76,6***	***58,7***	***63,6***	***64,1***	***61,5***
Minimum	***62,0***	***58,9***	***54,2***	***57,6***	***54,6***	***49,8***
N	***4***	***5***	***4***	***5***	***5***	***6***
Mean	***65,3***	***67,3***	***56,2***	***60,1***	***58,9***	***54,1***
Std. Dev.	***3,1***	***5,7***	***1,6***	***2,2***	***4***	***4,5***
Co.Var.	***4,7***	***8,5***	***2,8***	***3,7***	***6,8***	***8,3***

Table 14

Horse

Equid remains account for under 3% of the mammal bones but the 209 specimens are widely distributed. All of the diagnostic elements can be identified as horse, rather than donkey or mule (refs), and it is assumed that all of the bones are from horse. All parts of the body are represented in the bones but with a bias in favour of mandibles, loose teeth and foot bones. This is probably a taphonomic effect as these are sturdy and therefore persistent elements. There is no evidence for consumption but some of the foot bones show where they were cut or chopped and metapodia were sometimes retained for working (see below). Not all of the animals were fully adult at death; usually, because horses are only rarely consumed, horse bones are mainly from adult and even aged animals. Age estimations from tooth eruption and crown height are limited by the small sample size. Animals of about 7 to 17 years at death are represented with none from the younger or older age classes. Several of the bones have unfused epiphyses indicating animals under around three years, two years and, in two cases, under 15 months. Horses are not usually used before they are two or three years old and modern Icelandic horses are not usually worked until four years old and, like other horses, can continue until past 20. There are no indications of disease on the unfused bones and the reason for death at this young age is not known. There are, indeed, very few indications of pathology on the horse bones; two with age-related fusion of lateral metapodia, a radius with slight exostosis near the distal epiphysis and a skull with an unusual deep-set pit in the temporal. Several bones are sufficiently complete for measurements; these include eight complete longbones from which estimates of withers heights can be calculated (Table 15). The range of the withers heights is 1.208 – 1.415 m with a mean of 1.328 m. These are not large horses but fit very well with the size of the modern Icelandic Horse of 1.25 – 1.42 m.

	element	measurement Cl/Ll (mm)	withers height (m)
	humerus	248,0	1,208
	radius	326,0	1,415
	tibia	320,0	1,395
	metacarpus	202,0	1,295
	metacarpus	199,0	1,276
	metacarpus	220,0	1,410
	metatarsus	246,0	1,311
	metatarsus	246,0	1,311
Total N	***max wht***	***min wht***	***mean***
8	***1,415***	***1,208***	***1,328***

Table 15

As the Icelandic Parliament passed a law in 982 AD against the importation of horses (Íslendingabók 1968), the modern animal is a direct descendant of these first imports and we can be reasonably sure that by the time of the occupation at Skriðuklaustur they were very similar to the modern animal, an usual situation for archaeological material. Their general size is like that of most medieval horses in Europe, but they are likely to have also been particularly hardy as today, having being deliberately and naturally selected. Whether or not the famous tölt gait was already prominent by this period is not clear, nor whether it affects bone morphology. Further metric data is given in the archive tables for future consultation.

Marine mammals

Whales are represented only by a small number of worked bone fragments (see below) from an unknown species, but one much larger than porpoise.

Remains of seals are a minor but consistent part of the assemblage at 78 specimens. Seal bones are distinctive compared to the other bones in the assemblage and most of the fragmentary vertebrae, ribs and limb bones are likely to have been identified except where very small pieces are present. They are, however, not easy to distinguish to individual species, particularly if the bones are or fragmentary or from juveniles. The material was compared with recent specimens and by consulting Hodgetts (1999). Several bones could be identified with some certainty as harp seal, some were a better match for grey, others were a smaller type, perhaps harbour seal. Grey and harbour seals are resident in Iceland, while the harp seal occurs when floating ice spreads south in hard winters. The distribution of anatomical elements is uneven (Table 16) with a bias in favour of the most solid bones such as the phalanges and the distinctive ear bullae (photo 41668 img_0382b).

Element	NISP
skull	1
otic bulla	3
maxilla	1
mandible	1
incisor unassigned	1
lower canine	1
upper incisor	1
upper canine	1
tooth	3
humerus	3
humerus	1
radius	3
radius	1
ulna	2
scapula	1
pelvis	2
sacrum	3
femur	3
tibia	7
fibula	1
metacarpal 2	1
metatarsal 1	3
metatarsal 2	1
metatarsal 3	2
metatarsal 4	1
tarsal	1
metapodial	1
phalanx 1	14

Summary	**Total**	***percent***
area		
head & neck	**8**	*10*
teeth	**7**	*8,8*
shoulder	**1**	*1,3*
pelvis (and sacrum)	**5**	*6,3*
foreleg	**10**	*12,5*
hindleg	**11**	*13,8*
metapodia	**9**	*11,3*
phalanges	**17**	*21,3*
ribs, other bones	**12**	*15*

phalanx 3	2
phalanx not assigned	1
axis	1
cervical vertebra	1
lumbar vertebra	2
rib	9
total	80

Table 16

41668 IMG_0382b

A high proportion of head and flipper elements could be interpreted as being from delivery of only skins to the site, but in fact there are several ribs, humeri, femora and other 'meat' bones suggesting that whole carcasses arrived at the site for consumption as well as for the skins. Butchery marks visible on eight of the bones, including a pelvis, radius and a vertebra, provide supporting evidence for division of the carcass. The bias against some bones, such as the scapula, can be interpreted as largely taphonomic. Pathologies were noted on two bones; some extra bone growth around the acetabulum edge and an extreme bone proliferation all round a first phalanx, perhaps a reaction to an infection (photo 61376 img_0303b).

61376 IMG_0303b

Small carnivores: dog, artic fox and cat

The combined total NISP for bones of this class is 105. Most of the bones could be identified as dog with a further 39 identified only to Canidae. Some of these latter might be of arctic fox, *Vulpes lagopus*, five bones of which could be positively identified. There are four bones of cat and a further two that could be either cat or arctic fox.

Taking the cat first, the four bones are a maxilla, tibia, scapula and a metacarpus III. The two indeterminate bones are an incomplete metapodial and a rib. The bones are from four different areas and are therefore unlikely to be from a single individual although the MNI (minimum number of individuals) is only one.

Of similar size but with canid morphology are five bones that have been identified as arctic fox. Three of these are from area H and might be from one individual. The bones are a scapula, humerus and radius, all from the right side. Of interest are the fine cut marks around the distal end of the humerus (photo 41603 img_0387b).

41603 IMG_0387b

Skinning marks are more usually found on the lowest elements of the limbs and where the skin is close to the bone, for example near the eye. These marks around the humerus are perhaps more indicative of meat removal. Within the indeterminate material there are three very small phalanges from area H that could also belong to this forelimb. The two other bones assigned to arctic fox are a calcaneum and a partial humerus. This latter was classed as arctic fox because it is even smaller than that of a Yorkshire terrier in the reference collection of 25 cm shoulder height. There is also a partial ulna in the indeterminate material that is of similar size. All of the metapodia match dog either on gross size or, where very small, on their sturdy proportions and have therefore been recorded as dog.

The bones directly attributed to dog thus number 55 with a further 39 indeterminate Canidae bones, many of which are probably also of dog. Most bones were found in ones or twos across the site but several bones were found in area V. All but one of the limb and foot bones are from the left side and are probably from one sub-adult individual, similar in size to a Jack Russel terrier. The single bone from the right side is a pathological femur. This is bent and thickened, suggesting a part healed greenstick fracture. In area H the dog remains include a skull of similar size and general shape to a small spaniel or terrier with little dorsal crest (photo 50255 img_0404b).

50255 IMG_0404b

Most of the remains are of similar small-medium animals. The more complete dog bones were measured (see archive tables). Shoulder height estimates were calculated for several bones and, excepting one metacarpus 5, range from 33.3 cm to 42.1 cm. All the dog bones were also compared with recent specimens and are similar to small dogs up to 44 cm at the shoulder, such as spaniel, fox terrier, miniature poodle. In Iceland today the local Icelandic Sheepdog usually has a height of 42-48 cm at the shoulder. This is a spitz type breed, thought to originate from Norwegian spitz type dogs brought over by the Viking settlers. As with the other Icelandic breeds of animal there is now a closed gene pool but there was probably little outside influence even before, the remains here therefore were probably represent dogs of similar type. The exception is the above mentioned 5th metacarpal from a larger animal. This has an estimated shoulder height of 60.3 cm, similar in size to modern dog types such as setter and rotweiller.

The presence of carnivores is also attested indirectly by gnaw marks on 4.9% of the bones and, in one case, by a coprolite containing bone fragments (Area I, photo 50134 img_0445b). A few bones have the characteristic sharp edges indicative of partial digestion (photo 30527 img_295b) In most cases the gnaw marks are not sufficiently distinctive to determine which animal was responsible. It is supposed that the majority were from the action of dogs but there are some bones with small, well defined, marks that are assumed to have been made by cat.

50134 IMG_0445b

30527 IMG_0295b

Birds

Bird bones are only a minor component of the faunal assemblage; the 70 bird bones comprise less than 1% of the total number of specimens. At least 13 taxa are represented with the most numerous being swan at 30 specimens. Some of these bones can be definitely identified as whooper, *Cygnus cygnus*, (photo 41797 img_0399b) and, as this is the only swan visiting Iceland today, it is assumed that all remains are of this species (nb. the two bones listed as *C. olor* at Gásir are assumed to be a misprint). They breed in Iceland during the summer, wintering in Britain (Cramp *et al* 1977). Most of the indeterminate fragments are also likely to be of swan, others are probably of geese and two are from smaller birds.

41797 IMG_0399b

Identification of the seven definite goose bones to species is difficult as there are several very similar species to consider. None of the bones are of the small, *Branta*, group of geese but are of the larger, *Anser*, group of grey geese. The largest bones are probably of domestic goose or the greylag, *Anser anser*, its ancestral form. The smaller bones are probably of pink-footed goose, *Anser brachyrynchus*. Both species are summer visitors to Iceland. One bone, a humerus, is a very good match with specimens of white-fronted goose, *Anser albifrons*. This species breeds in Greenland rather than Iceland but can be encountered in Iceland as a passage migrant. Ducks are represented by two bones; both could be of domestic duck or the ancestral mallard, *Anas platyrhynchos*. One of the two wader bones present matches dunlin, *Calidris alpina* (photo 51228 img_414b). The other is a plover, assumed to be the golden plover, *Pluvialis apricaria*, as this is the species found in Iceland.

51228 IMG_0414b

Other wetland and coastal birds are represented by one or two bones; they include cormorant, *Phalacocorax carbo*, guillemot, *Uria aalge*, and an indeterminate bone of a gull. There is also a single wing bone of white-tailed eagle, *Haliaeetos albicilla* (the only eagle in Iceland). There are eight bones of galliform birds in the assemblage; seven of these can be identified as the resident ptarmigan, *Lagopus mutus*, commonly identified in Icelandic assemblages (photo 60990 img_0306b). he other bone is a humerus from a small domestic fowl. This domestic bird is very uncommon in Icelandic assemblages; the two found at Skutustadir, for example, are thought to be the only ones from the entire Myvatin area (Hicks & Harrison 2008).

60990 IMG_0306b

Finally, although they could not be identified to taxon, there are two bone fragments that do not match any of the above species; one is possibly of coot and the other may be of fulmar or razorbill. The anatomical distribution is biased in favour of the larger and most sturdy elements; apart from one swan scapholunar and a swan-sized phalanx, there are no toes or other small elements and no skull bones. This is probably taphonomic; they did not survive, were removed by scavengers or were missed in excavation, but disposal of waste parts beyond the excavation area cannot be entirely ruled out. Butchery marks are not common but they can be seen on four swan humeri and on the fowl humerus. In each case they indicate either where the wing was removed from the body or where the lower part of the wing was cut off. There are also three cases where a swan bone has been cut and further worked - see below.

Fish

Remains of fish account for 21% of the total bone count, although they are much smaller than the sheep and cattle bones and individually represent less meat. Preservation of the fish bones is variable, sometimes very good but frequently poor and difficult to handle without causing further damage to fragile structures. It is highly likely that many more fish remains were originally present but have not survived, and also that small elements will be underrepresented because they were missed in excavation. The original contribution of fish to the diet may, therefore, have been higher than indicated from the surviving number of bones.

The fish taxa list at Icelandic sites is often restricted and this is also true of Skriðuklaustur, with only five or six species present. The majority of the fish bones determined to species or family are of Gadidae and most of these are definitely or probably of cod, *Gadus morhua*. Ling, *Molva molva*, and haddock, *Melanogrammus aeglefinus*, are also present in small numbers and a saithe, *Pollachius virens*, was identified in the preliminary sample (Pálsdóttir 2006). The other class of fish identified is that of sharks. These remains are unusual and will be described later. Salmonids, found at several of the earlier, Viking period, sites are completely absent.

Many of the fish remains were classed as indeterminate; these include the undiagnostic elements such as fin rays and vertebral spine fragments, minor cranial elements and fragments that could be determined only as fish. Bones positively identified as cod number 488, 23.3% of the total fish and almost 63% of the bones identified to species or family. Many of the 158 bones identified only as Gadidae are probably also of cod, as bones of other gadid species are few. Ling bones, at 42 specimens, are ten times less frequent than those of cod but are also represented by all parts of the fish with head, pectoral and caudal elements present. There are very few haddock bones, just nine cleithra and two caudal vertebrae. Haddock is frequently biased in this manner with the large, hypostosed, cleithra the most commonly surviving element. One of these shows evidence of gnawing and another had been cut (photo 50223 img_436b).

50223 IMG_0436b

There is some bias within the cod elements; the numerically best represented bones are cleithrum, premaxilla, ceratohyal, posttemporal and vertebrae. This is mainly for taphonomic reasons; these are large sturdy bones (photo 50228 img_434b) but are also easily recognised even when in a poor, fragmentary, state. The dentary is also recognisable from incomplete and damaged specimens (photo 41339 img_4701b).

50228 IMG_0434b

41339 IMG_4701b

There are not enough vertebrae to match the other elements but as many were reduced to crumbling centrum fragments and not identified to species, it seems highly likely that many did not survive at all. Of those that do survive, caudal and precaudal are present in approximately natural proportions. The presence of both head and body bones suggests that whole fish were arriving at Skriðuklaustur, rather than just the processed fish (without the head) found at most non-coastal sites. The distribution of the fish elements and summary totals are given in Table 17a, b.

distribution details	cod	ling	haddock	Gadidae	shark	indet	Total NISP
neurocranium	1						1
otolith	2						2
frontal	4						4
supraoccipital	1						1
parasphenoid	2						2
vomer	5	2					7
other cranial element	18	1		7		44	70
post temporal	23	1					24
ectopterygoid	5						5
quadrate	4	2		1			7
hyomandibular	15	3		1			19
preoperculum	9	4					13
operculum	15	1					16
interoperculum	1						1
suboperculum	18			3			21
ceratohyal	21						21
epihyal	8						8

other face element	1			9		1	11
maxilla	15	1		1			17
premaxilla	25	1					26
dentary	14	2		1			17
articular	14	2					16
total head							309
cleithrum	42	9	8	9			68
postcleithrum	22		1	2			25
supracleithrum	21	1		1			23
total pectoral							116
precaudal vertebra	64	5		9			78
caudal vertebra	110	7	2	21		2	142
vertebra not assigned	3			13	77	7	100
total vertebrae							320
rib				49		1	50
fin ray						185	185
branchiostegal ray	1			31		24	56
ray/spine/rib fragments						607	607
other elements	4					3	7
fragment						440	440
total other + indeterminate							1345
Total NISP	488	42	11	158	77	1314	2090
% overall	*23,3*	*2,0*	*0,5*	*7,6*	*3,7*	*62,9*	
% identified	*62,9*	*5,4*	*1,4*	*20,4*	*9,9*		776

Table 17a

distribution summary	cod	%	ling	%	haddock	%	indet. Gadidae	%	shark	indet.	%
head elements	221	*45,3*	20	*47,6*			23	*14,6*		45	*3,4*
pectoral elements	85	*17,4*	10	*23,8*	9	*81,8*	12	*7,6*			
precaudal vertebra	64	*13,1*	5	*11,9*			9	*5,7*			
caudal vertebra	110	*22,5*	7	*16,7*	2	*18,2*	21	*13,3*		2	*0,2*
vertebra not assigned	3	*0,6*					13	*8,2*	77	7	*0,5*
other + indeterminate	5	*1,0*					80	*50,6*		1260	*95,9*
Total	488		42		11		158		77	1314	***2090***
percentage of total	*23,3*		*2,0*		*0,5*		*7,6*		*3,7*	*62,9*	
% of identified	*62,9*		*5,4*		*1,4*		*20,4*		*9,9*		***776***

Distribution	all gadid	%
head elements	264	*43,0*
pectoral	116	*18,9*
all vertebra	234	*38,1*
Total	**614**	

Table 17b

Butchery marks on fish bones are rare in comparison with mammals, 1.3% in comparison with 6.3% observed on mammal bones. Poor preservation may have obscured some marks but this should apply to both groups. The smaller body of fish requires less division for consumption and thus fish bones have fewer chances of cut marks. In processed fish cut marks are commonly seen on cleithra and the first few precaudal vertebrae, showing where the head was removed. Filleting and cutting into steaks can also leave marks on vertebrae. Cut marks were observed on 28 of the fish bones and include chopped cod and ling cleithra. This may indicate that, although whole fish are mainly represented, there is some evidence of processed fish at the site too.

In addition to the gadid material there are several elasmobranch vertebrae. With the exception of a group of four these are large; most are over 30mm across. Elasmobranchs are relatively rare in this area, except for the Greenland shark. This is the common large species found round Iceland, and has probably been exploited for liver oil (for lamps) and meat (for humans and dogs) since the first settlement. In the 19th century the shark fishery was of major economic importance. Their vertebrae, however, are not normally calcified and archaeological remains are very rare, two teeth were found at Finnbogastaðir (Edvarsson et al 2004). Apart from the small spurdog, and skates, the only large species found commonly in the area are basking shark and porbeagle. After consultation with other colleagues and collections it has been established that the vertebrae found at Skriðuklaustur are almost certainly of the porbeagle, *Lamna nasus*. This species is today most common around the southern part of Iceland. Many of these vertebrae, and perhaps all, had been modified to form beads (see below).

Finally, although not strictly fish, there is a claw fragment of a large crab (photo 52375 img_0448b).

52375 IMG_0448b

Bone working

Mammals

There is ample evidence for bone modification, despite the often poor preservation (Table 18).

swan	shark	haddock	**Total**	Total NISP	worked %
			8	571	1,4
			1	346	0,3
			1	147	0,7
			9	188	4,8
			2	115	1,7
1			**15**	607	2,5
			22	1575	1,4
			1	183	0,5
			5	161	3,1
			1	30	3,3
			15	1209	1,2
			3	142	2,1
	34		**45**	479	9,4
1	1		**16**	1174	1,4
	8		**10**	212	4,7
	2		**30**	1447	2,1
			2	120	1,7
			3	294	1
	1		**4**	128	3,1
1			**1**	68	1,5
1		1	**4**	541	0,7
			0	131	0
4	**46**	**1**	**198**	**9868**	***2,0***
2,0	***23,2***	***0,5***			

Table 18

The majority of modified mammal bones are of sheep metapodia. Many metapodia had been pierced, probably for marrow extraction, as described above. Several of these had been further modified by scraping down the shaft - perhaps during cleaning away traces of skin and membrane - and were then polished (photos 51088 img_0430, 70665 img_0364, 70875 img_0355).

51088 IMG_0430b

70665 IMG_0364

70875 IMG_0355

It is not possible to say whether this polish was prior to use or was produced by the use as a tool or handle. The size and shape of sheep metapodia with the proximal hole could make them useful as holders, e.g. for parchment prickers. As an alternative, at modern re-enactment events, sheep metapodia (without proximal holes) they are used as wool-winders. One partial metatarsus is modified in a different manner; this has five broad saw marks or grooves incised across the front of the shaft (photo 51652 img_0407b).

51652 IMG_0407b

Another shaft fragment, assumed to be sheep metacarpus on size and shape, has been carefully crafted into a flat rectangular 'billet' with a hole drilled at both ends (photo 71700 img_317b and 318b).

71700 IMG_0317b

71700 IMG_0318b

Horn working is evidenced by five horncores that have been sawn from the skull and a section of sawn horn (photo 70945 img_470b). This last is a rare find in archaeological assemblages as horn is keratin rather than bone and does not usually survive. Other modified sheep bones include a tibia with a hole drilled through the front of the distal part of the shaft and a scapula that is smoothed or worn all round the proximal edge, either for use as a small scoop or from use in this way.

70945 IMG_0470b

A cattle scapula from context 40019 in area F had also been modified for use as a scoop or shovel; most of the spine was removed and the scapula is worn smooth at the proximal end (photo 40019 img_0379b). There is also a slight polishing of the 'neck' of the scapula, where one might hold it for use as a scoop. There is damage to the proximal end that might have been the reason for its discard.

40019 IMG_0379b

Two horse scapulae were also found at this locus and thought to be scoops. These, however, show no signs of modification or wear. The slight rounding of the proximal ends is from canine gnawing, and several tooth puncture marks can be clearly seen. It is possible that these had been selected for use but had been discarded with the cattle scoop before being used. Another, less well preserved, cattle scapula scoop was found in area L. This also has had the spine removed and the proximal is smoothed, presumably from use (photo 50303 img_0410b). The distal end is damaged and missing (or perhaps was removed.). A metacarpus from area Q has a hole pierced into the proximal joint surface, perhaps in order to hold a tool?

50303 IMG_0410b

Horse metapodia were also found with modifications. From area L there is a sawn section made from a metacarpus and a short tube made by whittling a metatarsus. An offcut of a metatarsus that had been roughly sawn through was found in area Q (photo 72170 img_337b and 338b). In addition to these items there is a cattle/horse-sized limb shaft fragment with a sawn edge and a squared off conical peg or offcut (photo 71470 img_0319b).

72170 IMG_0337b

72170 IMG_0338b

71470 IMG_0319b

Five fragments of worked whalebone were found in area I, the probable infirmary. These are a slice of rib, a whittled bone slice and three thin offcut chips (photo 40524 img_0377b). It seems probable that these are all from one, unknown activity. A further fragment was found in area L; this is a small offcut or article shaped into a point.

40524 IMG_0377b

Birds

There are three modified swan bones, two radii and an ulna. Both of the radii have been cut off at both ends to form a long tube (photos 70678 img_0346b and 71639 img_0458b), the shafts had also been polished but there are no holes (as would be seen if they were flutes). The ulna appears to have been intended for the same type of item as it has been partly cut around the shaft and also at the distal end - where it has broken and was then presumably discarded (photo 50213 img_417b).

70678 IMG_0346b

71639 IMG_0458b

50213 IMG_0417b

Fish

One of the haddock cleithra, from area V, has a shaped cut that does not appear to be from butchery but is perhaps deliberate working (photo 71637 img_348b and 349b). Chess pieces carved from haddock cleithra have been found at some sites (Brewington *et al* 2004, McGovern *et al* 2009 in press) and perhaps this was intended to be one. All of the other modified fish bones are shark vertebrae.

71637 IMG_0348b

71637 IMG_0349b

Shark beads

More than half (46 of 77 specimens) of the porbeagle vertebrae show clear evidence of working; a hole has been pierced through the centrum to produce a large flat bead. The other shark vertebrae found may also have been modified but are too poorly preserved to tell. On some of the best preserved examples the edges of the hole can be seen to be bevelled smooth, either deliberately or by wear from, e.g., the passage of a cord through the hole (photos 60821 img_0280b, 50551 img_0261b, 51790 img_0253b). These are large vertebrae with a restricted size distribution, a plot of those that could be measured in at least one axis are given in fig. 2a, b.

60821 IMG_0280b

50551 IMG_0261b

51790 IMG_0253b

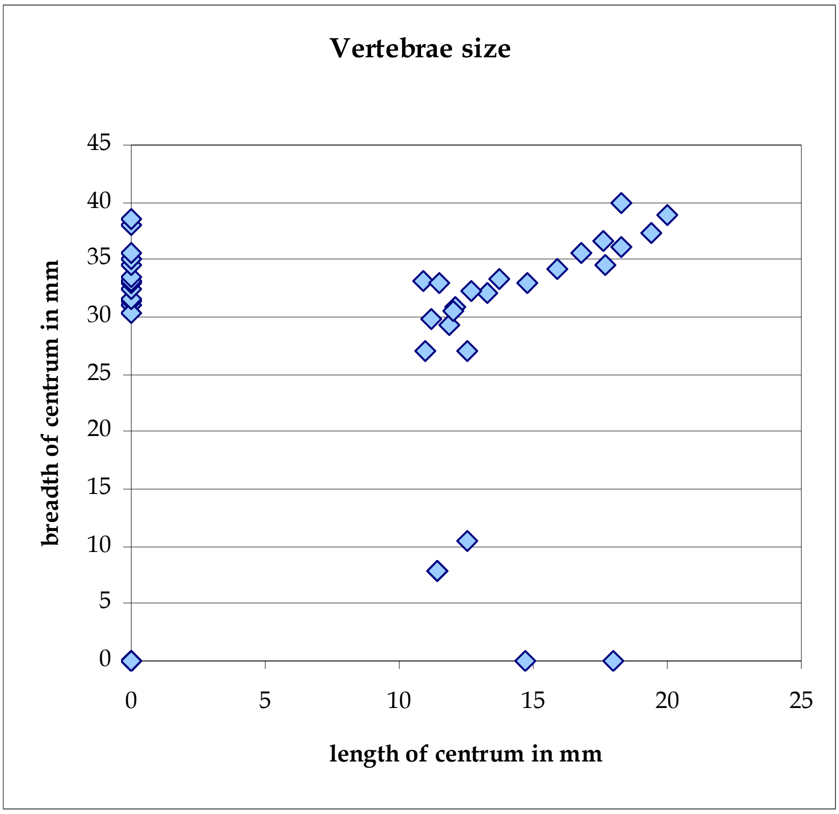

Figure 2a

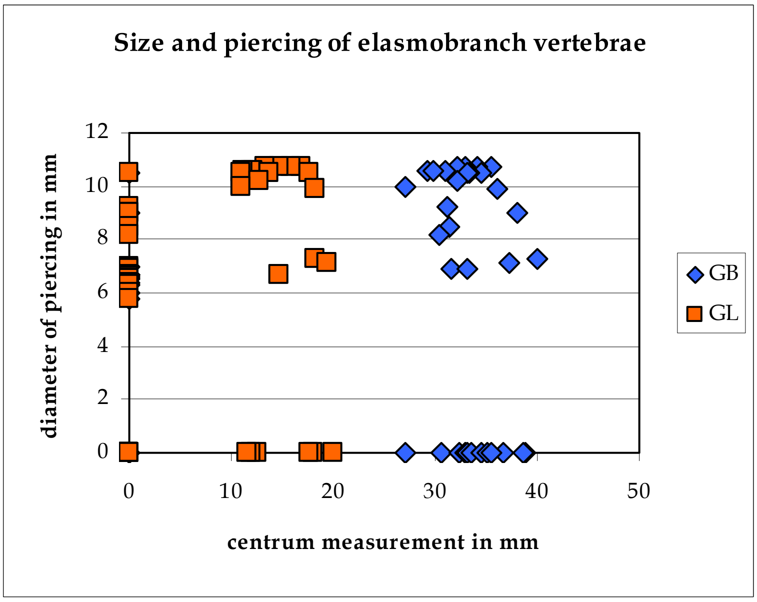

Figure 2b

The method of recording the finds from the excavation means that the precise location of each item is available for analysis. Preliminary results of the distribution study show that almost all of these vertebrae were recovered from areas N and O, inside the church (fig. 3).

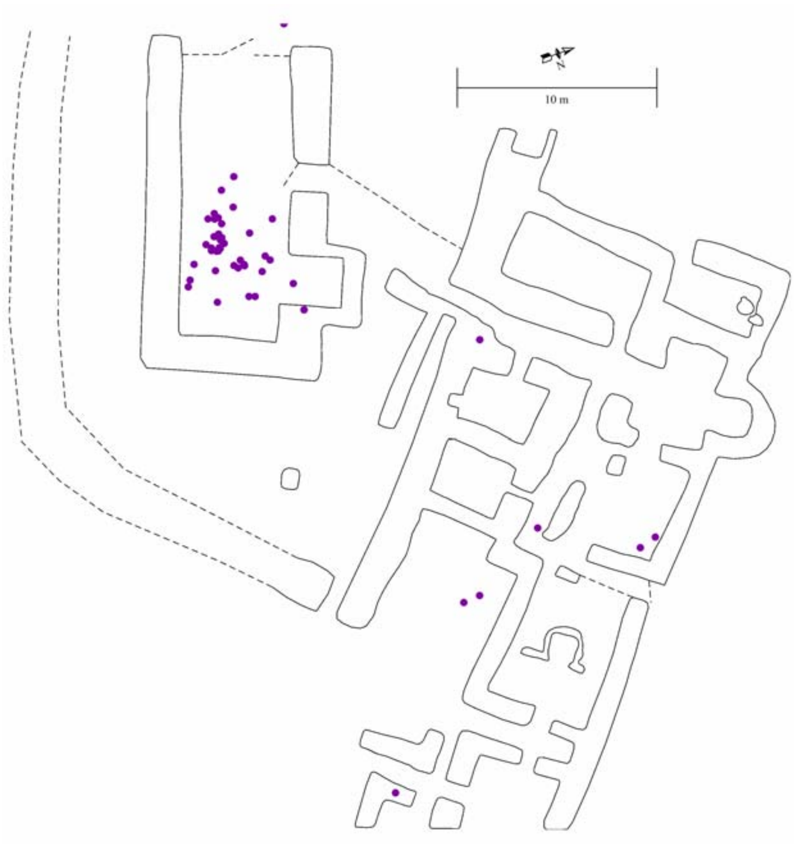

Fig. 3

The very few from elsewhere are from the entrance area and there is one from the latrine area. The vertebrae that could not be definitively recorded as worked are also mainly from inside the church. Not only are most from inside the church but they are also mainly from the southern part, which would probably be the chancel and near the altar. Stallibrass (2002, 2005) reported on perforated fish vertebrae from 13th-14th century deposits inside a chapel in northern England. These were thought to be from rosaries or paternosters; there is a tradition of burying these near altars or placing them round statues of the Virgin. Stallibrass also reports the depiction of a fishbone rosary in a polyptych of St. Vincent held in Lisbon. The beads found at Skriðuklaustur are rather large for the typical rosary, which also usually has 150 beads in sets of ten plus one paternoster between. Rather, these could be interpreted as simple paternosters of 10 or 11 large beads, or perhaps as a single 'wall rosary' meant for display. Perforated vertebrae have also been found at, amongst others, Saxon Southampton (Hamilton-Dyer 1997) and Poland (Makowiekci 2003). Here, and in other countries, fishbone necklaces have been associated with fertility and warding off evil. The adoption into Christianity, with the obvious association with fish and fishermen, may have drawn on these existing beliefs.

Discussion

Skriðuklaustur monastery lasted only around 50 years and, apart from the church, no subsequent building activity took place on the site. The faunal assemblage is, therefore, relatively undisturbed and of a single period. This is in contrast to most other medieval assemblages, which often have multiple-period occupation. Bone preservation is variable and, although sometimes poor, most of the diagnostic elements could be identified to taxon.

The majority of the faunal remains are of mammals. These account for just over 78% of the total specimen count with around 21% fish and birds under 1%. The 7707 mammal bones are dominated by those of sheep, with cattle in second place. Other mammals are horse, dog, seals, arctic fox, cat and whale. Bird remains are mainly of swans, geese and ptarmigan.

The sheep remains account for over 70% of the identified mammal bones and would have provided the bulk of the meat supply. They would also have supplied wool, milk, skins and bone for tools. Distribution of elements indicates the presence of complete animals rather than selected joints. The same is true of cattle, their remains are considerably less frequent than those of sheep at 1 : 4 cattle to sheep. A relatively high number of the bones are of neonatal or very young calves, around 13% in comparison with only 0.3% for sheep. This emphasis on dairying is typical for Iceland from the time of the first settlements. In a monastic and hospice context the calves would have been especially useful both for vellum production and for feeding the young and sick. In comparison with other sites the sheep and cattle assemblage is most similar to that of the high status farm at Bessastaðir with a lower proportion of cattle than at the island monastery on Viðey, the farm at Stóraborg, or the coastal trading station at Gásir (see Table 19). Although cattle is at a lower level than at these sites, it is close to that of the large Viking assemblage at Hofstaðir, where it is pointed out that, at many of the rural settlements cattle bones are rare (McGovern et al 2009).

The amount of seal remains is relatively high and unlike any assemblage other than Gásir (Harrison 2009). The tradition of using seal skins for book covers (Kristjánsson 1968) might help to explain some of the seal remains, but the inhabitants were not averse to eating them either. Pope Sixtus IV wrote to bishop Magnús Eyjólfsson of Skálholt in 1461 to allow seal to be classed as fish for eating on fast days (Íslenskt fornbréfasafn (1857). That some of the remains are of harp seal indicates seasonal hunting, when harsh winters bring the sea ice south.

Horse remains are a minor component of the assemblage but are more common than at most sites. The measurements provide useful data for comparison with modern specimens of the Icelandic horse. Unlike at Viking sites there is no evidence for consumption.

The dogs, apart from one, are all small - or very small and sometimes difficult to distinguish from arctic fox, which is also present. Small dogs have also been identified at other sites including Gásir (Harrison 2009). Some of these can be regarded as lap dogs and thus perhaps indicating high status, although it should be remembered that small terriers can also have use, for example as rat catchers. The

Spitz type dogs and the modern Icelandic sheepdog are not large either and most bones here could be from this type of working dog.

Ptarmigan and seabirds rather than domestic fowl are typical for this harsh environment but the seabirds and ducks found commonly at some sites are almost absent at Skriðuklaustur. Unusually most of the bones are, instead, from whooper swan, together with geese and ptarmigan, while remains of other birds are negligible. Apart from use for meat and fat, swans and geese are an obvious supply of feathers for writing quills and there is considerable evidence at the site for manuscript production, including ink-cooking pits, parchment prickers and colouring materials (Kristjánsdóttir 2003). It is interesting to note that the assemblage from Storaborg farm, while not containing swan, is dominated by bones of geese and also contained several domestic fowl bones (Table 19). These are usually very rare in Icelandic assemblages, one was found at Skriðuklaustur.

The fish remains are not typical of earlier, Viking period, settlements. Unless situated at the coast, these sites have mainly processed gadids, without the head bones, and usually have salmonids as well (Hofstaðir for example – see Table 19). The fish assemblage is not the same as other late medieval assemblages either. At these sites the fish remains are almost entirely of processed cod and other gadids. At the inland, consumer, sites there are very few head bones, an underrepresentation of vertebrae with caudal vertebrae dominant, and some pectoral elements, especially the rear part of the cleithrum. Medieval processing sites on the coast are mainly reversed with large numbers of head bones and the thoracic/precaudal vertebrae discarded in processing, together with a few bones from whole fish consumed at the site (Krivogorskaya *et al* 2005). Skriðuklaustur is clearly not a coastal producer site, yet there is a high proportion of head bones in the assemblage, along with cleithra and vertebrae, both pre-caudal and caudal. The cut marks so often seen on pectoral elements and precaudal vertebrae from processed fish (Barrett *et al* 2008), are only rarely encountered here and, in addition, both of the cut parts can be present. The fish are also quite large, the size best suited to preserving is around 60-110 cm total length (Amundsen *et al* 2005) but many of the bones at Skriðuklaustur would have come from fish well over 1m. At Gásir (Harrison 2009) many of the cod, thought to be from local exploitation, were much smaller than this and the remainder appeared to be traded cod, already processed.

The implication must be that, while some of the fish supplied may have been the standard processed type, it was mainly complete, and probably fresh, fish that were being used at Skriðuklaustur. It has been suggested that this ability to order fresh fish indicates the relative wealth of the monastery. The large size of several of the fish may indicate that the supply included fish normally considered oversize for processing. Those in charge of provisions were either able to purchase from coastal processors or trading settlements, or were perhaps in direct control of a fishing station/booths. It is also possible that some provisions were gifted from grateful relatives or patrons, either direct from fishers and farmers or through the traders.

	Skriðuklaustur		Bessastaðir		Viðey		Stóraborg		Gásir 2009		Hofstaðir	
	monastery		high status farm		island monastery		farm		coastal trading station		high status farm	
	15th-16th		14th-15th		14th-16th		14th-15th		13th-15th		Viking II	
horse, *Equus caballus*	209	*5,6*	15	*0,8*	1	*0,2*	12	*0,6*	15	*0,7*	42	*0,8*
cattle, *Bos taurus*	634	*17,0*	285	*16,0*	213	*35,9*	649	*30,7*	756	*35,8*	1163	*21,7*
sheep/goat, *Ovis/Capra*	2882	*77,4*	1470	*82,7*	377	*63,5*	1441	*68,2*	1562	*73,9*	3954	*73,8*
pig	0	*0,0*	7	*0,4*	3	*0,5*	11	*0,5*	34	*1,6*	199	*3,7*
dog	55	*1,5*	7	*0,4*	0	*0,0*	0	*0,0*	15	*0,7*	0	*0,0*
seals	78	*2,1*	3	*0,2*	3	*0,5*	4	*0,2*	61	*2,9*	11	*0,2*
other identified mammals	17	*0,5*	33	*1,9*	11	*1,9*	4	*0,2*	34	*1,6*	12	*0,2*
	3725		**1777**		**594**		**2113**		**2367**		**5358**	
swan	30	*55,6*	0	*0,0*	0	*0,0*	0	*0,0*	2	*0,9*	0	*0,0*
geese	7	*13,0*	10	*13,7*	0	*0,0*	215	*44,4*	0	*0,0*	0	*0,0*
ducks	2	*3,7*	34	*46,6*	0	*0,0*	0	*0,0*	39	*17,7*	9	*5,8*
ptarmigan	7	*13,0*	8	*11,0*	0	*0,0*	0	*0,0*	0	*0,0*	132	*84,6*
domestic fowl	1	*1,9*	0	*0,0*	0	*0,0*	22	*4,5*	0	*0,0*	0	*0,0*
other and indet. birds	7	*13,0*	21	*28,8*	0	*0,0*	247	*51,0*	179	*81,4*	15	*9,6*
	54		**73**		**0**		**484**		**220**		**156**	
cod and other Gadids	699	*90,1*	3860	*100,0*	1439	*99,7*	730	*100,0*	4554	*99,3*	2758	*22,8*
other fish species	77	*9,9*	1	*0,03*	5	*0,3*	0	*0,0*	32	*0,7*	9320	*77,2*
	776		**3861**		**1444**		**730**		**4586**		**12078**	
total fish bone	**2090**		**8608**		**1804**		**11430**		**12936**		**16379**	
total bone fragments	**9868**		**10857**		**3079**		**14090**		**25756**		**59669**	
total fish % of NISP	*21,2*		*79,3*		*58,6*		*81,1*		*50,2*		*27,4*	

Table 19

Conclusion

The animal bone assemblage from Skriðuklaustur has several unique features in comparison with other late medieval sites, and also in comparison with earlier, Viking period, material. The dominance of sheep is typical for Iceland but the presence and relative amounts of other taxa do not resemble any other site exactly. Horse, seal and dog bones are more frequent than at most sites. Seal skins may have been used in the production of manuscripts but there is ample evidence that the meat was also used. Bird remains are mainly of swan and goose; the feathers were probably used as quills for the manuscripts. Fish remains are mainly of cod but are mainly of whole fish rather than headless, processed, ones. Most unusual is the presence of a number of shark vertebrae modified as beads. These were almost entirely recovered from inside the church and may be the remains of rosaries or similar votive objects.

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Skýrslur Skriðuklaustursrannsókna

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