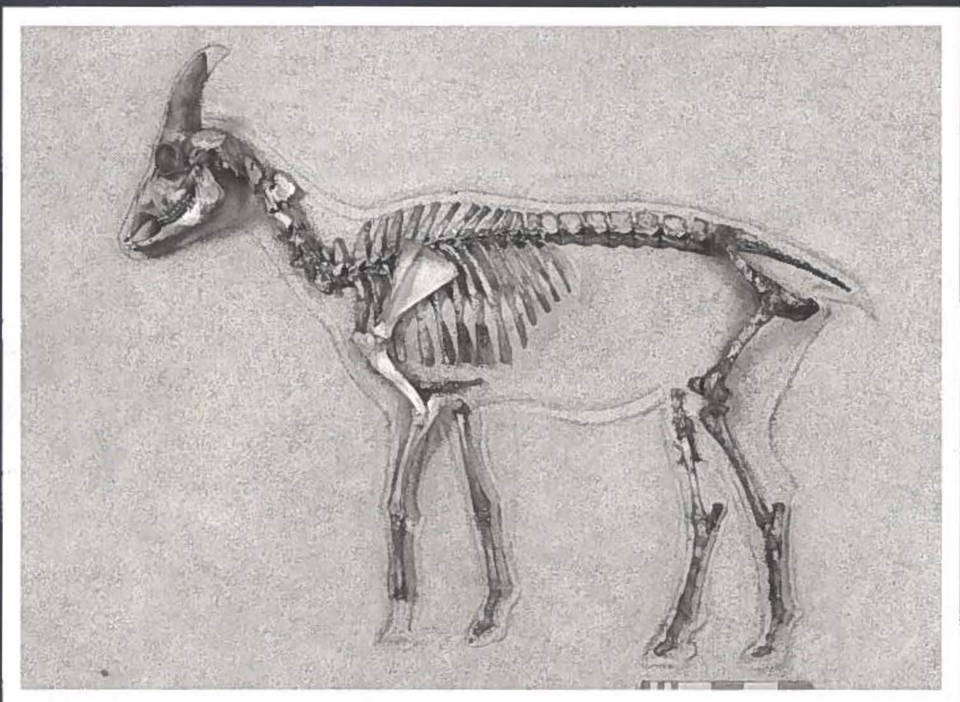
MEDDELELSER OM GRØNLAND

Hunting, fishing and animal husbandry at The Farm Beneath The Sand, Western Greenland

An archaeozoological analysis of a Norse Farm in the Western Settlement

Inge Bødker Enghoff



MAN & SOCIETY

28 · 2003

Hunting, fishing and animal husbandry at The Farm Beneath The Sand, Western Greenland

Publication no. 1 from the archaeological investigations at the Farm beneath the Sand 1991-1996

Published in cooperation with SILA, the Greenland Research Centre at the National Museum of Denmark and the Greenland National Museum & Archives

SILA
THE GREENLAND RESEARCH CENTRE
AT THE NATIONAL MUSEUM OF DENMARK

Hunting, fishing and animal husbandry at The Farm Beneath The Sand, Western Greenland

An archaeozoological analysis of a Norse farm in the Western Settlement

INGE BØDKER ENGHOFF

– with a chapter on the archaeological background
by *Jette Arneborg*

MEDDELELSER OM GRØNLAND • MAN & SOCIETY 28 • 2003

Inge Bødker Enghoff: Hunting, fishing and animalhusbandry at the Farm Beneath The Sand, Western Greenland. An archaeozoological analysis of a Norse farm in the Western Settlement. Meddelelser om Grønland, Man & Society vol. 28. Copenhagen, Danish Polar Center, 2003.

Publishing editor Kirsten Caning
Printed by Special-Trykkeriet i Viborg a-s

Scientific Editor:
Hans Christian Gulløv, The National Museum of Denmark, Ny Vestergade 10, DK-1471 Copenhagen K, Denmark. Phone (+ 45) 3313 4411, fax (+ 45) 3347 3320, email hans.christian.gullov@natmus.dk

For more information and a list of publications, please visit the web site of the Danish Polar Center *http://www.dpc.dk*

All correspondence concerning this book or the series *Meddelelser om Grønland* (including orders) should be sent to:

Danish Polar Center, Strandgade 100 H, DK-1401 Copenhagen, Denmark, email dpc@dpc.dk

Accepted December 2002
ISSN 0106-1062
ISBN 87-90369-59-9

Contents

Abstract

Enghoff, I.B. 2003. Hunting, fishing and animal husbandry at The Farm Beneath The Sand, western Greenland – An archaeozoological analysis of a Norse farm in the Western Settlement. Meddelelser om Grønland, Man & Society 28, 104 pp. Copenhagen 2003.

A large and generally well preserved sample of animal bones was excavated at "The Farm Beneath The Sand" (Gården under Sandet, GUS) in the Norse Western Settlement in Greenland. The sample represents the entire period of occupation, from ca. AD 1000-1400 and could be divided into three time phases, allowing analysis of changes in the economy of the farm. A total of 8,250 bone fragments, from at least 36 species of fish, birds and mammals, were identified.

The 166 fish bones from GUS constitute the hitherto largest sample from a Norse site in Greenland. The generally poor state of preservation of the fish bones, in combination with the fact that fish bones were only found in sieved samples, indicate that fishing may have played a larger role than the sheer number of fish bones indicates. The majority of the fish bones are from Arctic char (*Salvelinus alpinus*), followed by cod (*Gadus morhua*) and capelin (*Mallotus villosus*).

The material of bird bones is strongly dominated by ptarmigan (*Lagopus mutus*), but there are also bones of, e.g., geese, auks, whooper swan (*Cygnus cygnus*), mallard (*Anas platyrhynchos*) and eider (*Somateria mollissima*). Remains of wings of White-tailed eagle (*Haliaeetus albicilla*) and a goose were found.

The GUS people exploited the wild mammal fauna but also kept domestic animals. Bones of seals numerically dominate the mammal bone material. Reindeer (*Rangifer tarandus*) was also important, and Arctic hare (*Lepus arcticus*) was a smaller but constant element. Second in numerical importance among the mammals is sheep+goat which strongly dominate among the domestic animals. Right from the first time phase, the number of goats (*Capra hircus*) almost equals that of sheep (*Ovis aries*). The find of a complete goat skeleton is of particular interest. Cattle (*Bos taurus*) was also kept at GUS, whereas the find of only a single bone of swine (*Sus domesticus*) does not prove pig husbandry. Measurements of metacarpal and metatarsal bones indicate that sheep, goats and cattle were small and stout. Age estimates based on, i.a., tooth eruption and wear patterns indicate that cattle were kept mainly to provide milk. For sheep and goats, a more mixed exploitation is indicated, however, with the main emphasis on meat production.

There are several indications of temporal changes in the economy of GUS: The exploitation of seals increases, and while common seal (*Phoca vitulina*)

dominates the first phases, there is a change towards dominance of harp seal (*Phoca groenlandica*) in the later phase. The exploitation of reindeer decreases, sheep and goat become slightly more numerous, and cattle becomes scarcer.

GUS was an inland farm, and its overall economy seems to have been strongly based on exploitation of the inland fauna: hunting of ptarmigan, geese, reindeer and hare; seals brought in from nearby breeding grounds; fishing for char, maybe at the mouth of the river in the nearby fjord. Hunting and fishing was combined with animal husbandry dominated by sheep and goats, and with a little cattle. Excursions must have been made to the seacoast to obtain harp seals and walruses (*Odobenus rosmarus*). Throughout the period of occupation the relation between bone fragments of wild and domestic mammals was ca. 1:1, whereas the animal food gradually became more dominated by marine species: in phase 1, 29% of the fragments are from marine species, versus 44% in phase 3.

A fair number of bones from horses and a skull and mandibles from greyhound-type dogs indicate that the farm had a certain level of status.

Inge Bødker Enghoff, Zoological Museum, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, email: ibenghoff@zmuc.ku.dk

The archaeological background

Jette Arneborg

The Farm Beneath the Sand (*Gården under Sandet* – GUS) is the name that has been given to a Norse farm found in 1990 (Kapel 1991) and investigated archaeologically in the period 1991-1996. The farm lies in the inland area east of Nuuk and south of Austmannadalen (Fig. 1). The site where the farm lies has no official place-name, and the name reflects the fact that the farm ruin was covered by metres of sand and gravel deposits when it was found.

The Western Settlement and the area around The Farm beneath the Sand

The climate of the South Greenland coasts is described as decidedly oceanic with limited temperature differences between summer and winter. If one moves from the outer coast in towards the inland ice sheet, the temperature differences increase while the precipitation decreases (Hansen 2000:26). The Western Settlement of the Norse Greenlanders lay in the interior parts of the

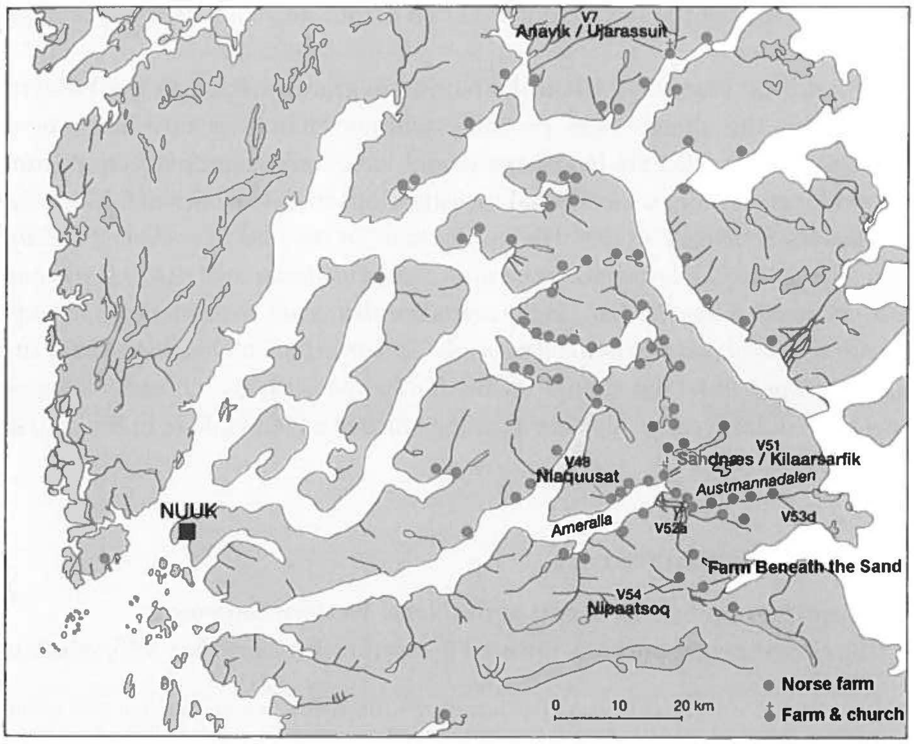


Fig. 1. Farms in the Western Settlement.

Godthåb and Ameralik/Ameralla fjord systems, and the vegetation there is described as dry, low arctic with dwarf-scrub heaths (Kalaallit Nunaat Greenland Atlas 1990:42). Comparisons of temperature measurements made in Kapisillit, which like GUS is inland in the Western Settlement some 40 km from it as the crow flies, and Igaliku, which is centrally placed in the Norse Eastern Settlement, show that the climate in the inner parts of the Western Settlement is considerably more continental than in the central parts of the Eastern Settlement. The mean temperature for the warmest month (July) is more than 10°C in both places. The difference between the two settlement areas is evident in the winter months, when it is considerably colder in the Western Settlement, and the growth season is both shorter and less rainy in the Western Settlement.

The landscape immediately around GUS is dominated today by an extensive plain of sand and gravel, surrounded by up to 700-800 metres of high mountains. The huge gravel and sand deposits were brought there by the meltwater from the large glacier that projects from the inland ice sheet west of the farm complex. Besides the glacier, the delta has received water from Buksefjord[1] and old, now dried-out river beds show that the rivers have changed their courses several times. The water volumes and the movements of the rivers are determined by the great glacier, and at some point – after the Norse farm had been abandoned – the water of the river flowed directly over the farm ruin and covered it with the thick sand and gravel deposits. Today the river is again working its way north towards the farm ruin, and upon the way it removes tons of the sand and gravel that it once deposited in the area (Figs 2-3).

Around the year 1000, when the Norse emigrants arrived in the Western Settlement, the climate was probably warmer than it is now (Schweger 1998:16), and at GUS the landscape would have looked quite different from what we can see today. Geological investigations in the vicinity of GUS show, in Charles Schweger's (1998:17) words, that *"at the time of settlement a clear, meandering river likely watered a vegetated floodplain dotted with oxbow ponds and wet meadows. Adequate clean water, vegetation that could be dried for fodder, and extensive upland pastures would have made GUS an attractive, productive farm site ..."* Schweger links the change in the landscape with the climatic changes towards colder weather that set in in the Northern Hemisphere in the course of the 1300s.

The neighbouring farms

GUS is in the southernmost part of the Norse Western Settlement.

The closest neighbours are, towards the south west, Farm No. V55, which is

1. In connection with the building of the Buksefjord hydroelectric power station in 1993 a dam has been built at the mouth of the Buksefjord on the Nipaatsoq plain, and the Buksefjord River is today completely dried out.

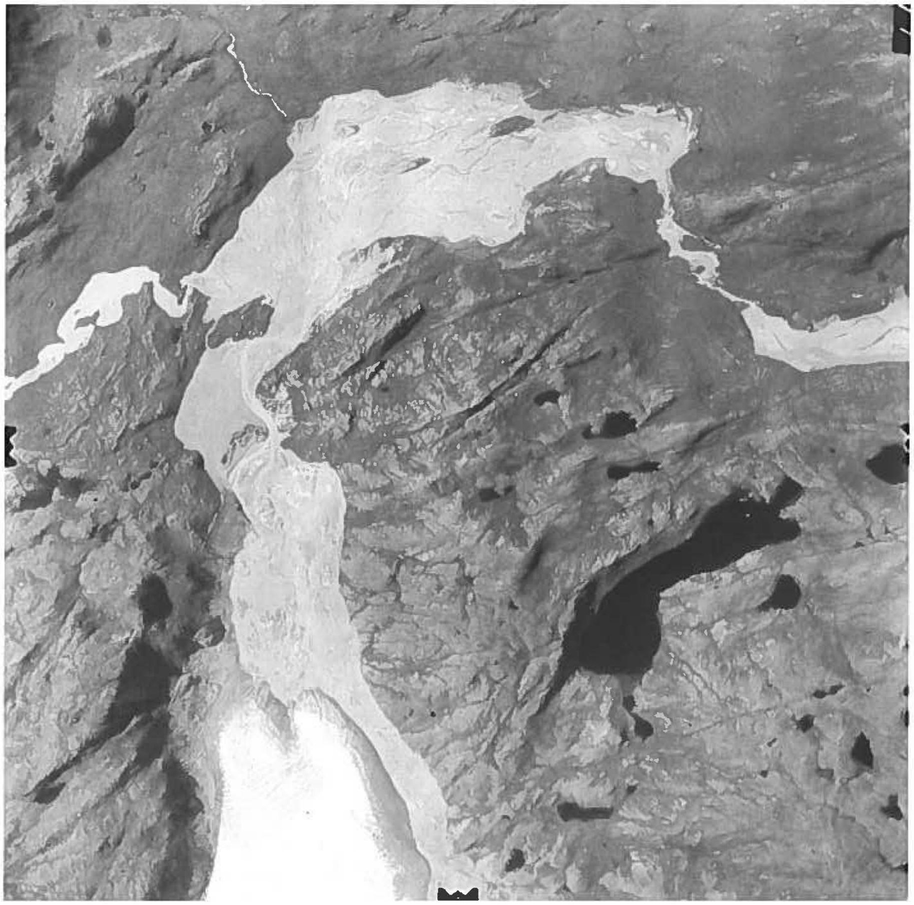


Fig. 2. Aerial photograph of the Nipaatsoq area with glacier.

by the lake Isortuarsuk, and towards the north east Farm V54 at Nipaatsoq. While the terrain towards V55 is today almost inaccessible because of the large river delta, one can get to Nipaatsoq on foot in less than a couple of hours. North of *GUS* in Austmannadalen lie a string of Norse farms, and at the head of Ameralla, at Kilaarsarfik, lie the ruins of what was probably the area's largest farm, Sandnæs. Archaeological excavations have been conducted at all these sites, as well as at the small coastal farm Niaquusat by the entrance to Ameralla (e.g. Andreasen 1982; Arneborg 1985; McGovern *et al.* 1996; McGovern *et al.* 1983; Møhl 1982; Roussell 1936; Roussell 1941).

We know hardly anything about the social relations among the farms, but in the archaeological picture the Sandnæs farm stands out strikingly from other farms. The farm is favourably situated with large accessible pasture areas for the farm animals, and zooarchaeological investigations show that its stock of domestic animals was dominated by prestige-conferring cows, unlike the other farms, where sheep and goats predominated (McGovern *et al.* 1996). The architecture is characterized by the many houses that lie

Fig. 3. The river delta adjacent to The Farm Beneath the Sand. Photo: Jette Arneborg 1995.

spread over a largish area, and the only identified church of the region was at this farm. The very presence of the church suggests that the farmer at Sandnæs must have played a central role in the social life of the region.

The archaeological investigations at The Farm Beneath the Sand

The first trial investigations at The Farm Beneath the Sand were conducted in 1991 (Andreasen and Arneborg 1992), and over the next few years until 1996, for the first time in the history of Norse archaeology, the buildings of a Norse farm from the last-used buildings back to the first house built at the site were uncovered (Figs 4-6).

In connection with the excavations some 3,600 archaeological finds were gathered in the form of artefacts, animal bones and various material samples for scientific analysis. During the collection of the finds two documentation principles were used, depending on whether the objects were found individually or several identical finds were made – for example the animal bones – in a largish well defined area, for example in one room. In the case of a number of finds we have information on whether the find comes from a floor layer, wall fill, wall turf, a fill layer or similar elements which form part of the construction of the building. A number of things were collected as stray finds outside the find context. Typically these are finds that were washed out of the context and collected on the sand banks along the river. In the analytical

Fig. 4. Digging away the 1,5 meter thick layer of sand and gravel that covered the cultural layers. Photo: Jette Arneborg 1992.

Fig. 5. The stable of the last phase farm. The stable could house one or two cows placed on both sides of the dividing stone. Wooden pegs still sitting in the turf wall indicate, that also sheep and goats were housed in the stable. Georg Nyegaard is cleaning up the gutter. Photo: Jette Arneborg 1994.

phase we also have finds where the information about the find has been lost for unknown reasons. These are classed as stray finds.

According to the documentation principles used the finds can be classed in three main groups:

I. Stray finds

II. Finds collected from a large well-defined area, for example floor layers in rooms. In a few cases finds in this group come from sieved samples. This is the case when it was established in the field that the collection had been done in a safe floor layer.

III. Finds documented in three dimensions (coordinates and level) within the framework of the established measuring system. Most of the finds in this group are marked on the survey plans. In a few cases the find-spot is only documented by coordinates and level.

In all, 586 collections of animal bones have been entered in the find database. A 'collection' can comprise anything from one to many bones. Prior to the find analysis Group I (stray finds) comprised 58 collections or 10% of all, Group II (collections from well defined area) of 237 collections or 40% of all, while Group III (finds documented in three dimensions and marked on the plan) comprised 291 collections or 50% of the whole.

Chronology

Apart from the collections along the river, all the animal bones from GUS come from the actual building complex, which in its last phase took the form of a centralized farm unit. The overall chronological framework for the animal bones therefore takes its starting-point in the stratigraphic analysis of the building itself.

The building was made of nature's own material – stone and turf – as well as driftwood that had come to Greenland with the ice from its places of origin in the great forests of Siberia and Alaska.

A Norse farm seems to have been a perpetual building site, where new rooms were added, while others were either removed or simply allowed to collapse. The process did not deviate many metres from the place where the first building had been built. Instead people built either directly above older phases, later house phases were dug into formerly discontinued rooms, or new rooms were built close to standing rooms. Especially in the youngest construction phases the partitioning into rooms was clear, and the individual rooms were numbered in the field as they were identified. Other rooms were only identified in the analytical phase. In all 43 rooms were identified. In some cases several phases were registered, and divided into different con-

Lab ID	Material	Find no.	Room no.	C14 BP	Reservoir C14 BP	Cal. age	Cal. ± 1 SD	C13
K-6018	Cattle	x 0026	20	910±55		1160	1035-1215	20.2
AAR-1633	Terrestrial bone	x 0053	2	875±60		1190	1050-1240	18.4
K-5823	Reindeer antler	x 0139		395±50		1465	1440-1615	18.8
K-6017	Sheep/goat	x 0222	1	730±50		1285	1270-1300	20.0
AAR-5401	Horse	x 0575	1	536±30		1410	1334-1425	21.2
AAR-5405	Horse	x 0575	1	566±36		1335-1401	1326-1413	21
AAR-5400	Cattle	x 0678	3	619±26		1317-1388	1301-1396	19.9
AAR-1636	Sheep/goat	x 1009	1	645±55		1310-1380	1290-1400	17.4
K-6631	Sheep/goat	x 1097	5	520±45		1420	1405-1435	19.4
AAR-1637	Sheep/goat	x 1279	3	700±55		1290	1280-1380	20.1
AAR-2508	Walrus tooth	x 1441	1	1105±60	655±60	1325	1295-1395	12.8
AAR-1638	Sheep/goat	x 1464	5	680±55		1300	1280-1390	19.2
AAR-3394	Cattle	x 2849	17	845±60		1220	1160-1280	20.8
AAR-3735	Reindeer	x 2890	19	890±35		1170	1055-1215	18.1
AAR-4291	Goat	x 2943	22	710±45		1290	1280-1300	19.5
AAR-4461	Goat	x 2943	22	785±30		1260	1220-1280	19.58
AAR-3395	Reindeer	x 3072	17	890±55		1170	1040-1220	18.8
AAR-3900	Seal (*Phoca* sp.) astragalus	x 3074	13	1410±35	1010±35	1020	1005-1030	14.1
AAR-5406	Sheep	x 3259.	0	825±33		1220	1191-1259	19.9
AAR-3899	Sheep/goat phalanx	x 3447	13/27	965±35		1035	1020-1155	19.2
AAR-3397	Sheep	x 3451	17	945±35		1045-1150	1030-1160	20.2

Table 1. *Overview of Carbon-14 datings.*

struction phases. Svend Erik Albrethsen and Gudmundur Ólafsson (forthcoming) are responsible for the investigation of the very complicated construction history of the Farm Beneath the Sand, and they have divided the many rooms into eight construction phases whose interrelationships are based on the stratigraphic analysis of the buildings and the distribution of finds (by J. Arneborg), while the absolute chronology is based on Carbon-14 datings (Radiocarbon dates of animal bones, Table 1)

The eight construction phases have been dated:

Construction Phase 1: ca. 1000-1050 (cf. Albrethsen and Ólafsson 1998).
Construction Phase 2: ca. 1050-1100
Construction Phase 3: ca. 1100-1150
Construction Phase 4: ca. 1150-1200
Construction Phase 5: ca. 1200-1250
Construction Phase 6: ca. 1250-1280
Construction Phase 7: ca. 1280-1340
Construction Phase 8: ca. 1340-1350

Fig. 6. View over The Farm Beneath the Sand 1994. Photo: Jette Arneborg.

Group II finds from well-defined areas are placed in the stratigraphic skeleton in accordance with the find information from the field. However, several finds with information on a connection with a room, for example, will appear outside the phase groupings, if the find information has not been safely verified in the analytical phase.

Group III items have been placed in accordance with the find data available. As with the Group II finds, if it has not been possible to place finds convincingly, they are placed outside the phase groupings.

In the placing of the animal bones it has not been possible to use the very fine phase divisions used in the construction analysis, among other reasons because in several cases the phase divisions are based on changes that were made within individual rooms, and it has been difficult if not impossible to attribute finds with certainty to the individual phases of the functional period of a room. Although experience from the midden investigations shows that were regular clearances from the floors of the farms (McGovern *et al.* 1983:98), and floor finds can therefore usually be assigned to the most recent period of use, I have for safety's sake assigned the finds to all the phases a room has gone through.

Since for the placing of the animal bone finds a broader framework was used than the one with which the stratigraphic construction analysis operates, the very fine chronological skeleton of the construction phases has been grouped in four analytical units, the fourth of which comprises finds that are assigned to the period after the Norse farm had been abandoned. The other three analytical units are referred to as cover the periods:

Phase 1 ca. 1000 – ca. 1150 (Construction Phases 1, 2 and 3)
Phase 2 ca. 1150 – ca. 1300 (Construction Phases 4, 5 and 6)
Phase 3 ca. 1300 – ca. 1400 (Construction Phases 7 and 8)

It is well known that the turves used in the construction of a Norse farm often contain archaeological finds (see for example Andreasen 1980:139), and this was also the case at GUS. Finds from the floor layers, especially in the rooms used last, may therefore come from the last functional period of the room, or they may have dropped down on the floor from roof and wall turves in the period of decay – after the farm had been abandoned. The separation of the two events in the find material is impossible. Since in the building situation the construction turves were cut from the top, most recently formed grass layers, in the placing of finds from wall and ceiling turves I have assumed that the finds from the construction turves are contemporary with the functional period for the room of which they form part. However, one must be aware of the obvious sources of error in the finds from the top floor layers when these are used in synchronic analyses of distribution patterns, for example in connection with the analyses of the functions of the rooms.

In accordance with the principle described it has been possible to place 384 finds in the chronological system:

29 collections or 5% of all have been placed in Phase I (ca. 1000 – ca. 1150)
79 collections or 13% of all belong to Phase II (ca. 1150 – ca. 1300)
249 collections or 43% of all belong to Phase III (ca. 1300 – ca. 1400)
24 collections or 4% of all belong to Phases II and III
3 collections or 1% have been assigned to the period after the Norse farm had been abandoned.

But it has not been possible to place 202 collections or 34% of all bone collections within the framework of the phases and analytical units.

Setting the scene

The Farm beneath the Sand (GUS) was situated in the West Greenland inland: close to a river near one of the inner branches (Ameralla) of the Ameralik Fjord System, about 80 km from the Greenland west coast.

The area offered a wide range of resources to the immigrants. The green pastures were well suited for animal husbandry, and the immigrants brought with them a stock of domestic animals, intending to keep them at GUS as they were used to from their former home.

In addition, the surrounding nature housed a wild fauna of mammals, birds and fish, which could also be harvested.

During the period while GUS was inhabited, the climate in Greenland changed from warmer than today to colder than today. There was a Medieval Warm Period in Greenland from AD 900-1350, followed by the Little Ice Age 1350-1800 (see Schweger 1998 and Arneborg *et al.* 1999: 166). The change in climate caused increasing difficulties with maintaining the animal husbandry the same way as in the country of origin of the immigrant humans. At the same time, the climate change influenced the distribution of the wild fauna in the area.

Analysis of animal bones recovered at GUS provides an opportunity to gain insight into how the GUS people have met the challenges with 1) keeping domestic animals under different and increasingly harsh conditions and 2) learning how to exploit an unfamiliar, wild fauna. Also, the adaptation of introduced, domestic animals to the extreme conditions is subject of inquiry.

Material and methods

Method of bone recovery

A combination of hand picking of animal fragments and sieving of sediment was employed at GUS. Sieving was not employed in a systematic manner, but spot samples were wet-sieved through 1 mm, 3 mm or 5 mm meshes.

It is characteristic that bones of fish, birds, Arctic fox and Arctic hare are from sieved samples, these small species are therefore probably underrepresented in the material.

At the time when the site was discovered, the fore parts of the buildings had been destroyed by river erosion, and only the internal parts were left (Berglund 1998). The animal bones, on which the present analysis is based, were recovered mostly from various rooms in the buildings. There were many rooms including living rooms, working rooms and animal sheds, and often rooms had changed their functions during the period of occupation.

Unfortunately no middens were preserved.

Dating

The material from GUS is divisible into separate time phases, and there is material representing the entire time span of occupation. Material from most other Norse Greenland sites cannot be divided into phases, and most of them represent only the later part of the period of occupation (McGovern 1985).

The bone material has been subdivided according to three phases of occupation (see Jette Arneborg's chapter on the archaeological background). The subdivision of the material makes it possible to address the question, whether changes occurred in animal exploitation throughout the period GUS was inhabited.

State of preservation

Generally, the bones are very well preserved, with the exception of fish bones. Not only bones, but also keratinous material such as hair, nails, horns and whale baleens are preserved. This is due to the combination of permafrost and moderately acid conditions. In addition there are numerous fragments of egg-shells and feathers, and in some cases, remains of tissue still adhere to the bones.

The bones are as a rule strongly fragmented, which impedes identification. For the same reason, the number of measureable bones is small, as is the number of mandibles, which could be used as a basis for age estimation of mammals.

Some bones are burnt, and many bear cutmarks. Several bones bear toothmarks, partly from gnawing dogs or foxes, partly from mice.

Identification

The main tool for identification was the large collection of the Zoological Museum, University of Copenhagen, which includes large series of the relevant species of fish, birds, and mammals. In some cases, identification was assisted by specialised literature, cited in the pertinent paragraphs.

The entire excavated material of animal bones (24,643 fragments) was studied and identified as far as possible. All in all, 8250 bone fragments of fish, birds and mammals were identified. All fish bones, about half of the bird bones, and most of the mammal bones were identified by the author. Georg Nyegaard identified the 1051 mammal and 33 bird bones excavated during 1991-92 (ca. 13% of the bones), see Nyegaard (1991, 1992). Gitte Gotfredsen identified 44% of the bird bones, this included a re-examination of the bird bones identified by Nyegaard (Gotfredsen 1999). Carl C. Kinze identified the whale bones.

In most of the samples, there are also fragments of bivalve shells, mostly mussels (*Mytilus edulis*) but also scallops (*Pecten islandicus*).

The results of the identification, as well as various notes on the bones have been entered into an electronic database. The bone material is deposited in the Zoological Museum, University of Copenhagen.

Size and age estimation

Selected mammal bones were used for size and age estimates. For size estimations, in particular metacarpal and metatarsal bones were measured. For age estimation, the stage of epiphysal fusion was scored on a wider variety of bones; eruption and wear patterns for teeth were also studied.

Tooth nomenclature

For teeth, the following nomenclature was used. Permanent teeth are incidated with capital letters: P = premolar, M = molar. Decidiuous premolars are indicated with dp. The numbering of teeth starts anteriorly, teeth from the upper jaw are indicated with superscripted numbers, those from the lower jaw (mandible) with subscribed ones. For example: dp_4 = fourth deciduous premolar in the lower jaw. M^1 = first molar in the upper jaw.

Results of the identification

Tables 2-4 list the species of identified mammals, birds and fish, with the numbers of fragments from each of phases 1-4, as well as the total number of fragments shown. Tables 5-10 provide detailed information on representation of individual skeletal elements.

All numbers given in Tables 2-10 are numbers of fragments. I have chosen to present my results in this unmanipulated form. This corresponds to Number of Identified Specimens (NISP), "the single bone or tooth or fragment thereof assigned to some taxonomic unit" (Grayson 1984). NISP was recommended by McGovern (1992) for gradually accumulated bone assemblages like the present one.

It is true that different animal species have different numbers of bones, and that chances of preservation vary widely between different species and different skeletal elements. Large bones preserve better than small ones, and fatty bones usually decompose faster than less fatty ones. Furthermore, one individual of a large animal (e.g., a cow) represents much more food than one individual of a small one (e.g., a hare), even though both individuals may leave the same number of bone fragments to be recovered.

In a limited number of cases, several articulated bones were kept together during excavation, e.g., several bones from the same bird wing. However, such articulated assemblages were not looked for systematically. NISP sensu Grayson (1984) thus remains the most objective measure of relative frequency of species. The articulated finds that were recognized, are summarized in Table 11.

The detailed presentation of the results is organised as follows: First, the hunting of wild birds and mammals is treated, thereafter fishing, and lastly the animal (mammal) husbandry.

Species	Phase 1 (AD 1000-1150)	Phase 2 (AD 1150-1300)	Phase 3 (AD 1300-1400)	Phase 4 (AD 1400-)	Total
Arctic hare, *Lepus arcticus*	5	3	52		125
House mouse, *Mus musculus*[1]			58		63
Mouse, unspecified, Muridae indet.			1		1
Dog, *Canis familiaris*		2	17		36
Arctic fox, *Alopex lagopus*			1		1
Polar bear, *Ursus maritimus*		1	2		3
Walrus, *Odobenus rosmarus*	6	5	11		51
Common seal, *Phoca vitulina*	3	11	16		83
Ringed seal, *Phoca hispida*					1
Harp seal, *Phoca groenlandica*	3	8	34		118
seal, unspecified, *Phoca sp.*	147	147	1058	23	2867
Bearded seal, *Erignathus barbatus*	2	3	6	1	21
Hooded seal, *Cystophora cristata*			1		1
seal, unspecified, Pinnipedia indet.					7
Swine, *Sus domesticus*					1
Reindeer, *Rangifer tarandus*	149	61	331	10	1192
Sheep, *Ovis aries*	23	32	85	1	225
Goat, *Capra hircus*[2]	18	32	58	2	189
Sheep/goat	107	95	736	7	1742
Cattle, *Bos taurus*	82	50	158	9	659
Cattle/reindeer	2	3	21		55
ruminant, unspecified, Ruminantia indet.		1	8		11
Horse, *Equus caballus*	1	2	21		62
Longfinned pilot whale/killer whale, *Globicephala melas/Orcinus orca*			1		1
White-beaked dolphin/Atlantic white-sided dolphin, *Lagenorhynchus albirostris/L. acutus*					1
Bowhead whale, *Balaena mysticetus*		1			2
Bowhead whale/Northern right whale, *Balaena mysticetus/Eubalaena glacialis*					2
Whales, unspecified, Cetacea indet.		1	7		25
Identified mammal bone fragments	548	458	2683	53	7545
Unidentified mammal bone fragments	827	426	7976	94	16282
Grand total	1375	884	10659	147	23827

1. not including several samples with numerous bones of juvenile house mice together with remains of their fur.
2. not including one complete skeleton from phase 2.

Table 2. *Mammals from GUS. Entries are numbers of bones/bone fragments. Entries for "Total" include phases 1-4 plus bones/fragments not referred to a phase. Not included in the numbers are a whole goat skeleton, several samples containing juvenile house mice, modest numbers of horn fragments of sheep, goat and cattle, 23 seal claws, and 48 fragments of whale baleens.*

Species	Phase 1 (AD 1000-1150)	Phase 2 (AD 1150-1300)	Phase 3 (AD 1300-1400)	Phase 4 (AD 1400-)	Total
Whooper swan, *Cygnus cygnus*			1		4
Swan unspecified, *Cygnus sp.*			1		4
Goose unspecified, *Anser/Branta sp.*		1	15	1	47
Mallard, *Anas platyrhynchos*			5		5
Eider, *Somateria mollissima*					1
Eider/King eider, *Somateria mollissima/S. spectabilis*	1				5
Red-breasted merganser, *Mergus serrator*			1		1
Duck unspecified, *Anatidae indet.*			1		1
White-tailed eagle, *Haliaeetus albicilla*		8			10
Ptarmigan, *Lagopus mutus*	34	58	121		453
Guillemot/Brünnich's guillemot, *Uria aalge/U. lomvia*	1	5	9		31
Razorbill/Guillemot/Brünnich's guillemot, *Alca torda/Uria sp.*			3		8
Black guillemot, *Cepphus grylle*					1
Raven, *Corvus corax*			1		1
Identified bird bone fragments	36	72	158	1	572
Unidentified bird bone fragments	5	15	12		78
Grand total	41	87	170	1	650

Table 3. *Birds from GUS. Entries are numbers of bones/bone fragments. Entries for "Total" include phases 1-4 plus bones/fragments not referred to a phase.*

Species	Phase 1 (AD 1000-1150)	Phase 2 (AD 1150-1300)	Phase 3 (AD 1300-1400)	Phase 4 (AD 1400-)	Total
Arctic char, *Salvelinus alpinus*		1	33		47
Char/trout, *Salvelinus/Salmo*			15		22
Capelin, *Mallotus villosus*		7	1		29
Cod, *Gadus morhua*		26	3		31
Sculpin unspecified, Cottidae indet.			1		1[1]
Threespined stickleback, *Gasterosteus aculatus*		1			1
Halibut, *Hippoglossus hippoglossus*		1			2
Identified fish bone fragments		36	53		133
Unidentified fish bone fragments		6	23		33
Grand total		42	76		166

1. not including a mummified entire specimen which has not been referred to a phase.

Table 4. *Fish from GUS. Entries are numbers of bones/bone fragments. Entries for "Total" include phases 1-4 plus bones/fragments not referred to a phase.*

Species	cornus	calvarium	bulla	mandibula	dentes	os hyoideum	vertebrae cervicales	vertebrae thoracales	vertebrae lumbales	vertebrae caudales	vertebrae unspecified	costa	sternum	scapula	humerus	radius	ulna	radius + ulna
Arctic hare				1								1		2		1		
Walrus					4									1				
Common seal			2														1	
Harp seal			1	1														
seal, unspecified *(Phoca sp.)*		11			5		3	4	8	1	10	23		3	6	8	1	
Bearded seal																		
Reindeer	15	3			13		1	2	1			5		7	6	6	4	
Sheep	2	2		1											2	1		
Goat	1			1	1									1		1		2
Sheep/goat		7	2	8	17	3	6	3	1		2	2	1	3	8	4	1	
Cattle		14		8	10		2	2	2		1	4		3	2	2		
Cattle/reindeer		1																
Horse					1													

Species	carpales	metacarpales	metacarpales/-tarsales	pelvis	os penis	femur	patella	tibia	fibula	astragalus	calcaneus	tarsales	metatarsales	ossa sesamoides	phalanx 1	phalanx 2	phalanx 3	phalanges unspec.
Arctic hare																		
Walrus					1													
Common seal																		
Harp seal						1												
seal, unspecified *(Phoca sp.)*	1	4		2		1	2	1	3	1		8	10		13	7	3	8
Bearded seal									1				1					
Reindeer	3	5	1	5		6	2	10	3	9	7	2	4	5	8	4	5	8
Sheep		1								6	2		3			3		
Goat		1								3	1				3		2	
Sheep/goat	1	1	4	1		10	1	10		1	1	1	2	3	2	1		1
Cattle	5	5				1		1		2			4	2	3	4	3	1
Cattle/reindeer								1										
Horse																		

Table 5. *Specification of mammal bones from GUS, phase 1 (AD 1000-1150). Entries are numbers of identified bone fragments of each skeletal element of each species.*

Species	cornus	calvarium	bulla	mandibula	dentes	os hyoideum	vertebrae cervicales	vertebrae thoracales	vertebrae lumbales	os sacrum	vertebrae unspecified	costa	sternum	scapula	humerus	radius	ulna	radius + ulna
Arctic hare								1							1			
Dog					1													
Polar bear					1													
Walrus					3													
Common seal		1	1	1	7												1	
Harp seal		1	1											1	2		1	
seal, unspecified *(Phoca sp.)*		8	2	4	6		2	6	4	1	6	28	1	6	5	5	2	
Bearded seal							1					1						
Reindeer	11	1			5		2	1		1		1		4	3	3		2
Sheep	2	4		1										2	1			
Goat[1]	2			1			1									2		2
Sheep/goat		2		4	22	1	2	3			6	2		3	1	3	1	
Cattle				1	14		4	1				1		2	1			
Cattle/reindeer											1	1			1			
Horse					2													
Bowhead whale											1							

Species	carpales	metacarpales	metacarpales/-tarsales	pelvis	femur	patella	tibia	fibula	astragalus	calcaneus	tarsales	metatarsales	ossa sesamoides	phalanx 1	phalanx 2	phalanx 3	phalanges unspec.
Arctic hare					1												
Dog		1															
Polar Bear																	
Walrus				1												1	
Common seal																	
Harp seal					2												
seal, unspecified *(Phoca sp.)*	4	4	1	2	3	1	7	5	3	1	2	4		7	5	4	6
Bearded seal																	1
Reindeer		1		1	5	5	5		1	1	2	5			1		
Sheep			1				1		4		2	2	4	3	5	1	
Goat	7	2	1						4				1	3	3	2	
Sheep/goat	1	4		5	6	1	10			1	2	1	5	5	2	1	
Cattle	2	2	5	2			2		2	1			1	7	1	1	
Cattle/reindeer																	
Horse																	
Bowhead whale																	

1. not including one complete skeleton

Table 6. *Specification of mammal bones from GUS, phase 2 (AD 1150-1300). Entries are numbers of identified bone fragments of each skeletal element of each species.*

Species	cornus	calvarium	bulla	mandibula	dentes	os hyoideum	vertebrae cervicales	vertebrae thoracales	vertebrae lumbales	os sacrum	vertebrae caudales	vertebrae unspecified	costa	sternum	scapula	humerus	radius	ulna	radius + ulna
Arctic hare		9		3	4		4		1		11		2			3		2	
House mouse[1]		8		21	1		1					6			5	1			
Mouse, unspecified																			
Dog		1		2			4		2				2		1		1	1	
Arctic fox				1															
Polar bear				1	1														
Walrus					6								2						
Common seal		1	2	2	7										3			1	
Harp seal		5	5	3	4										5	4		4	
seal, unspecified (*Phoca sp.)*		50	4	1	40		30	45	18	4	25	28	148	30	21	20	26	16	
Bearded seal															1				
Hooded seal					1														
Reindeer	37	6	2	12	38	1	2	3	1		1	1	26	1	6	14	8	1	2
Sheep	7	4		4	5		1								1	5	5	2	
Goat	5	1		5	2		1									1	4		1
Sheep/goat	2	40	4	20	183	10	23	29	8	6	22	6	64	3	10	8	16	12	
Cattle		10	1	6	49	1	3		2		1		16		2	2	3		
Cattle/reindeer													4	2	1				
ruminant, unspecified	1				5														
Horse		5		7	1	2		1					2						
Longfinned pilot whale/killer whale													1						
Whale, unspecified											1								

Species	carpales	carpales/tarsales	metacarpales	metacarpales/-tarsales	pelvis	femur	patella	tibia	fibula	tibia + fibula	astragalus	calcaneus	tarsales	metatarsales	ossa sesamoides	phalanx 1	phalanx 2	phalanx 3	phalanges unspec.
Arctic hare			1		2	2		3	1			2		2					
House mouse					1	6		4											
Mouse, unspecified						1													
Dog			1		1			1											
Arctic fox																			
Polar bear																			
Walrus	1						1												1
Common seal																			
Harp seal						4													
seal, unspecified (*Phoca* sp.)	32	7	36	15	21	18	3	25	18	1	6	8	16	59	6	46	106	61	59
Bearded seal	1							1			1			2					
Hooded seal																			
Reindeer	5		7	7	3	17	2	37			11	9	7	24	8	5	10	4	11
Sheep			12	4		2		2			13	3		6		2	3	3	
Goat			4	1				1			16	3		1		2	2	4	
Sheep/goat	10	1	23	20	6	25	3	21	6		4	10	21	12	13	29	34	11	19
Cattle	3		5	1	2	1	1	3	1		3	5	1	5	2	8	9	5	6
Cattle/reindeer				1				4						2	3		1	1	
ruminant, unspecified				1															
Horse						1		1								1			
Longfinned pilot whale/killer whale																			
Whale, unspecified																			

1. not including several samples representing complete skeletons of juvenile house mice together with remains of their fur.

Table 7. *Specification of mammal bones from GUS, phase 3 (AD 1300-1400). Entries are numbers of identified bone fragments of each skeletal element of each species.*

Species	calvarium	premaxilla	mandibula	vertebrae caudales	vertebrae sacrales	costa	sternum	scapula	clavicula	coracoideum	humerus	radius	ulna	carpale	metacarpus	pelvis	femur	tibia	metatarsus	phalanx unspec. (ala)
Goose unspecified																				/1
Eider/King eider							1/													
White-tailed eagle											/1	/1	/1	/1	/1					/3
Ptarmigan	/2	/1	1/2	/1	1/	2/3	5/3	2/1	1/1	5/2	4/3	1/2			/1	6/11	2/7	2/6	2/4	/8
Guillemot/ Brünnich's guillemot								/1		/1	1/3									

__Table 8.__ Specification of bird bones from GUS, phases 1 (AD 1000-1150) and 2 (1150-1300). Entries are numbers of identified bone fragments of each skeletal element of each species from phase 1 (before stroke) and phase 2 (after stroke).

Species	calvarium	vertebrae cervicales	vertebrae thoracales	vertebrae sacrales	costa	sternum	scapula	clavicula	coracoideum	humerus	radius	ulna	carpale	metacarpus	pelvis	femur	tibia	metatarsus	phalanx unspec. (ala)	unspecified limb bone
Whooper swan						1														
Swan unspecified					1															
Goose unspecified		1			1	1				1	1	1	1	3				1	1	3
Mallard								1	1	1		1						2		
Red-breasted merganser																		1		
Duck unspecified,																		1		
Ptarmigan	1	3	2	1	12	5	1	2	10	11	1	5		5	3	17	20	6	16	
Guillemot/ Brünnich's guillemot						8		1												
Razorbill/Guillemot/ Brünnich's guillemot						1	1			1										
Raven														1						

__Table 9.__ Specification of bird bones from GUS, phase 3 (AD 1300-1400). Entries are numbers of identified bone fragments of each skeletal element of each species.

Species	maxillare	dentale	articulare	hyomandibulare	keratohyale	epibranchiale	head bones, unspecified	coracoideum	basipterygium	spine, basipterygium	vertebrae praecaudales	vertebrae caudales	vertebrae unspec.	neural archs	Epurale	Hemal archs	Urostylus	fin rays
Arctic char	/1	/1		/2		/2		/1			1/4	/22						
Char/trout	/1		/1		/1		/1		/1		/2	/6	/1		/1			
Capelin		1/1	1/				2/											
Cod											/1	/1		/1		2/	1/	23/
Threespined stickleback										1/								
Halibut													1/					

Table 10. *Specification of fish bones from GUS. Entries are numbers of identified bone fragments of each skeletal element of each species from phase 2 (AD 1150-1300, before stroke) and phase 3 (AD 1300-1400, after stroke). There are no identified fish bones from phase 1.*

GUS sample no.	phase	species	bones	total no. of bones/bone fragments
MAMMALS				
x 1605	?	Arctic hare	vertebrae	7
x 1638	3	Dog	calvarium, 2 mandibulae, 2 vertebrae	5
x 1971	3	Sheep	calcaneus, astragalus	2
x 3200	2	Sheep	metatarsus, 2 tarsales, phalanx 1, 2 phalanges 2, phalanx 3, 4 ossa sesamoides	11
x 905	?	Goat	metatarsus, 3 tarsales	4
x 1890	?	Horse	astragalus, calcaneus, 4 tarsales, 3 metatarsale	9
BIRDS				
x 668	3	Goose	humerus, radius, ulna, metacarpus	4
x 3011	2	White-tailed eagle	humerus, radius, ulna, metacarpus, carpale, 3 phalanges	8
FISH				
x 3235	2	Gadid	urostylus, 2 hemal arches, 23 finrays	26

Table 11. *Articulated bone finds from GUS. The articulated finds listed below contribute to the bone/bone fragments numbers in Tables 1-3 with the numbers given in the last column here. The table does not include the whole goat, the numerous juvenile mice with remnants of fur, and the mummified sculpin, since these articulated finds have not been entered in Tables 1-3 either.*

Hunting

Birds

A total of 650 bird bones were found at GUS, representing at least ten species (Tables 3, 8, 9). The vast majority (80%) of bird bones are from ptarmigan but there are also bones from whooper swan, geese, mallard, eiders, red-breasted merganser, white-tailed eagle, auks and raven,

In addition to bird bones, many eggshell and feather fragments have been found.

Bird bones are present in all the phases of GUS, and the ptarmigan dominates strongly throughout the period of occupation of the farm (Fig. 7). Unlike the neighbouring site Sandnes (McGovern *et al.* 1996) there seems not to have been an increase in the importance of birds through time.

Four out of eight swan bones could be identified as whooper swan. Nowadays the whooper swan is a rare visitor to Greenland, but in the Norse period it probably bred in West Greenland (Salomonsen 1990; Gotfredsen 1999). Gotfredsen based her statement on a tibiotarsal diaphysis of a swan from GUS: the presence of a juvenile swan is proof of breeding.

Apart from the whooper swan the bird species identified from GUS are nowadays common in Greenland. Ptarmigan and geese, which are the most frequent species, would have been easy to obtain in the inland.

Fig. 7. Bones from ptarmigan excavated at GUS. Ptarmigan is the most important bird species at the site, accounting for 80% of the bird bones. The photo shows fragments of calvarium, coracoid, scapula, sternum, costa, humerus, radius, ulna, metacarpus, phalanges, pelvis, femur and metatarsus belonging to at least five individuals. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

It is worth noticing that the earliest subfossil finds of white-tailed eagle in Greenland are from the medieval warm period (Gotfredsen 1999).

Notes on identification

Geese – The goose bones found at GUS were all pooled in the group *Anser/Branta* sp. because there are no morphological differences between species in these two genera. It should, however, be mentioned that bones in the part of the material examined by G. Gotfredsen and complete enough for measuring, had proportions falling within the known ranges for white-fronted goose (one bone was, however, larger than known for this species). For this reason, Gotfredsen (1999) referred all goose bones from goose to this species. The goose bones examined by me were not measured, but merely compared with recent skeletons of relevant species; they also had the same size as bones of white-fronted goose. Judged from present-day distributions, most of the further seven goose species recorded from Greenland (Boertmann 1994) can be excluded. However, since the distribution areas of the goose species is known to undergo dramatic changes over time, I have chosen a cautious level of identification and have referred all goose bones, including those identified by Gotfredsen, to *Anser/Branta* sp.

Eider/King Eider – Six bones were identified to eider/king eider. There are no morphological differences between the two species, and although the king eider is generally smaller than eider, there is a small size overlap. Nowadays, both species occur in West Greenland in the Nuuk area. For this reason, the level of identification is *Somateria* sp.

Auks (guillemots, razorbill etc.) – The black guillemot could be identified with certainty. The two other species of guillemot in Greenland, guillemot and Brünnich's guillemot, could not be separated in the material, since the diagnostic bill bones have not been found – for some bones even the razorbill could not be excluded. Based on present-day abundance of the two species, most if not all bones of guillemot/Brünnich's guillemot are probably from the latter species and Gotfredsen (1999) chose to refer all bones of the genus Uria in the part of the GUS material that she studied, to Brünnich's guillemot. Again, I have chosen a more cautious approach.

Representation of bird bones

The most frequent species, ptarmigan is represented by bones from the entire skeleton, from head to toes.

Goose bones are far less frequent (total: 47 bones) but they seem to represent the entire skeleton, with the exception that the head (where the bones are very thin) is missing. There are more wing than leg bones, but this may be due to the generally smaller length and diameter of the latter.

The bones of guillemot/Brünnich's guillemot are all sterna, or bones asso-

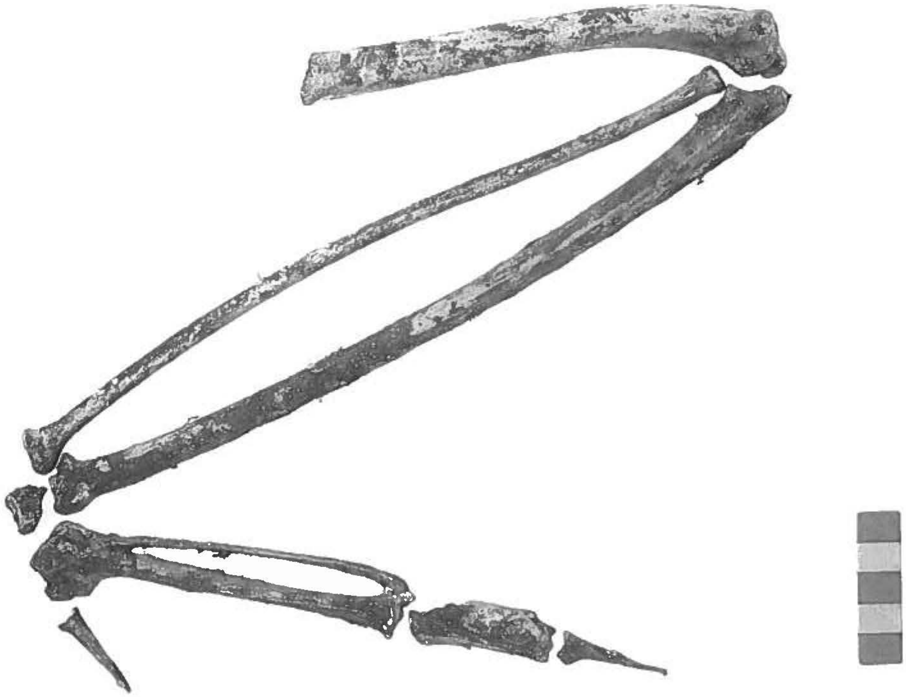


Fig. 8. Bones from the left wing of a white-tailed eagle, broken off through the proximal end of humerus. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

ciated with the sternum (scapula, clavicula, coracoid, costa, humerus), except a single fragment of the pelvis. According to Gotfredsen (pers. comm) this seems to be a general feature of Norse sites in Greenland, whereas entire guillemot skeletons are known from Eskimo sites (Gotfredsen 1997).

All ten bones of white-tailed eagle are wingbones (Table 8). Eight of them (humerus, ulna, radius, carpo-metacarpus, carpale and three phalanges) were found together and are from one single wing (find no. x 3011, Fig. 8). The humerus is broken proximally, and since the break is obviously ancient, this wing was probably broken off by the Norsemen. The single bone of raven is also a wing bone (carpo-metacarpus). A further wing, from a goose, was found in room I (find no. x 668, Fig. 9); the humerus of this wing has also been broken proximally, and radius, ulna and carpo-metacarpus are present as well. The four goose wing bones were situated in anatomical order, like a bent wing (Nyegaard 1992). Similar finds of eagle wings, as well as a single raven wing, are known from the Danish site Hjelm (1290-1306 A.D.) (Enghoff 2002), and these wings show the same humerus break as the wings from GUS. Eagle wing finds are known from several other Iron Age, Viking Age, and Medieval sites in northwestern Europe, including Ribe, Denmark (Enghoff MS), York, England (O'Connor 1989) and Haithabu, Germany (Reichstein 1974).

The remaining species of birds are too poorly represented to reveal possible trends in bone representation.

Fig. 9. Bones from the left wing of a goose, broken off proximally through humerus. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

Discussion of birds

The GUS material of bird bones is overwhelmingly dominated by ptarmigan throughout all phases (453 out of a total of 572 identified bones). Geese come second with 47 bones.

Ptarmigan as well as the geese (probably white-fronted goose) are inland birds and would have been easy to hunt in the immediate neighbourhood of GUS, due to the position of the site inland near the bottom of a long fjord system far away from the open sea. A similar dominance of ptarmigan bones is seen at the neighbouring Norse farm Nipaatsoq (McGovern 1985; Gotfredsen 1999). At Sandnes, which is situated closer to the main fjord than GUS and Nipaatsoq, there are twice as many bones of auks compared to ptarmigan: 159 ptarmigan bones and 295 auk bones out of a total of 492 identified bird bones (numbers based on information in Gotfredsen 1999). At other sites in the Western Settlement area, the dominance of auk bones is almost absolute, but contemporary bird bone assemblages from the Icelandic sites, Hofstaðir and Sveigakot (Tinsley in press) show a dominance of ptarmigan.

The regular presence of eggshells in the samples indicate that birds' eggs were collected, too.

The white-tailed eagle (and maybe the raven) may have served special purposes on GUS, since only wing bones are represented. The wing feathers may have been employed for decorative purposes or may have served as steering feather on arrows. Use of the wing as a broom is a further possibility, unless that eagle has been too highly revered for this very earthbound purpose – the goose wing found may be a better candidate for a broom.

Seals

No less than 3091, or 40% of the mammal bone fragments were identified as belonging to seals, and this group is herewith the numerically most important one in the GUS material. In addition to the bone fragments, numerous fragments of seal nails were also found.

Identification of seals to species is difficult and is only possible for certain skeletal elements, e.g. bulla, humerus, ulna, femur and teeth. All the seal species known from Greenland are represented in the material. Common seal (83 fragments) and harp seal (118) seem to have been by far the commonest species at GUS (Fig. 10), bearded seal (21) was rarer (Fig. 11), and only one fragment each could be identified as ringed and hooded seal. (Notice that the walrus, although systematically a seal, is not included in the present discussion of seals but is treated under "other animals"). Most fragments could only be referred to *Phoca* sp., i.e., either common, harp or ringed seal, these probably represent the three species in approximately the same proportions as the fragments identified to species.

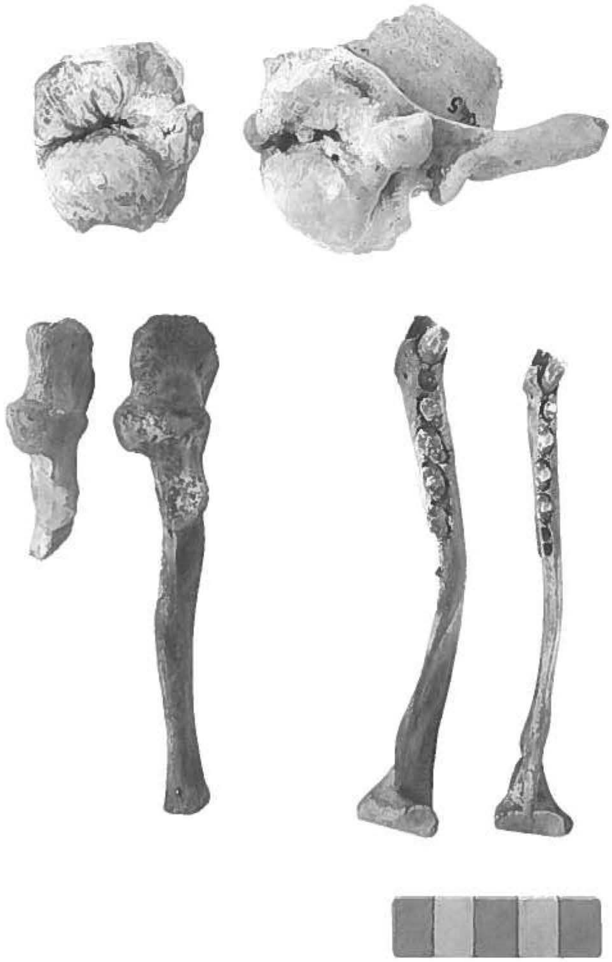
The entire skeleton of *Phoca* sp. is represented. This indicates that entire seal carcasses were brought to GUS although the farm was situated at some distance from the sea. One skeletal element was, however, entirely absent, namely the os penis (baculum). Absence of seal os penis is characteristic of Norse Greenlandic sites, as was already noticed by Degerbøl (1929). McGovern (1992) also noted the lack of seal os penis at Norse sites, in contrast to their abundance on Eskimo sites. McGovern (1992) hypothesised that the Norsemen eviscerated the seals before bringing them home, a process by which the os penis will often be lost.

The relative importance of seals in the household of GUS shows an increase from phase 1 (28%) through phases 2 (36%) and 3 (41%) (Fig. 12). This is a general tendency in Norse sites in Greenland, the chieftain's farm Sandnes being an exception (McGovern *et al.* 1996).

Harp seal is a migratory species, which passes up the Greenland west coast in spring and returns in the autumn. On its migrations, it also enters the fjords (Møhl 1982; Vibe 1990), although not very deeply. The inhabitants at GUS therefore must have had seasonal trips to the outer zone of the fjord in order to hunt harp seal (McGovern 1985).

Common seal is a stationary species, which occurs in West Greenland throughout the year. During summer, it goes far into the fjords and even into rivers. A breeding colony of common seal is known to have existed quite close to GUS, at the head of the Ameralla Fjord during historic times (McGovern

Fig. 10. Selected species-specific skeletal elements from common seal and harp seal, excavated at GUS. These are the commonest seal species at GUS. Above: bulla; below left: ulna; below right: mandible. The bone from common seal is shown to the left in each pair. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.



1985). In the breeding season, common seal depends on land and is therefore the most vulnerable of the Greenland seals (Vibe 1990). Twenty-nine fragments from baby seals (*Phoca* sp., pulli) are most probably from common seal (Figs 13-14), since the harp seal's breeding grounds are at Newfoundland. The baby seal bones prove that seal hunting took place during spring.

The preponderance of harp seal in the material fits into the general pattern seen in bone samples from the Western and Eastern Settlements where this species is usually the most numerous one. The large number of common seal bones is typical of Western Settlement sites; in the Eastern Settlement, common seal is usually much less numerous (Degerbøl 1936; McGovern 1985, 1992).

Whereas in the early phases (1 and 2) common seal is slightly better represented than harp seal, bones of common seal are markedly rarer in phase 3 Fig. 15). The difference between phases 1+2 and 3 is significant ($chi^2 = 3.876$, $p < 0.05$). A similar relative preponderance of common seal in the early phases of a settlement is seen in the Eastern Settlement site Narsaq (Ø17a)

Fig. 11. Right scapula of bearded seal, excavated at GUS. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

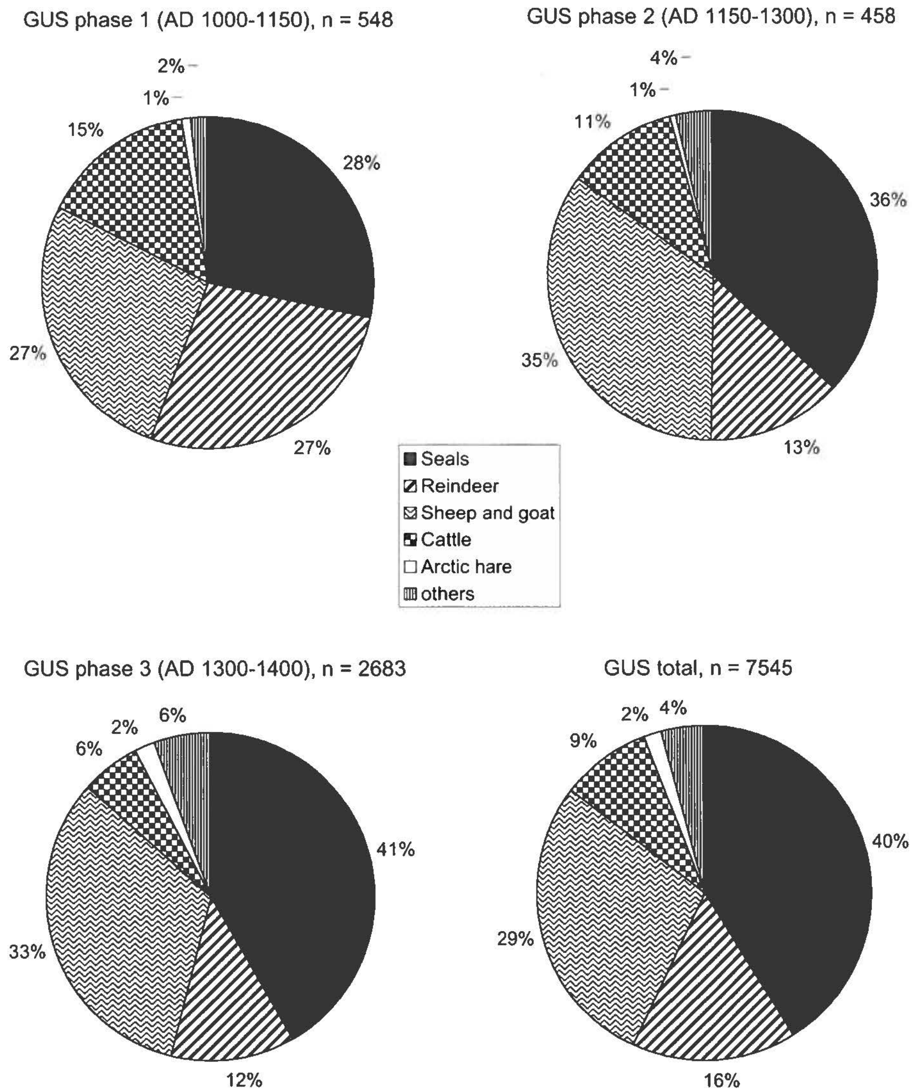


Fig. 12. Mammal bones from GUS. Relative frequencies of mammal species/species groups for phases 1-3 and for the total material, based on numbers of identified fragments. Photo: G. Brovad, Zoological Museum.

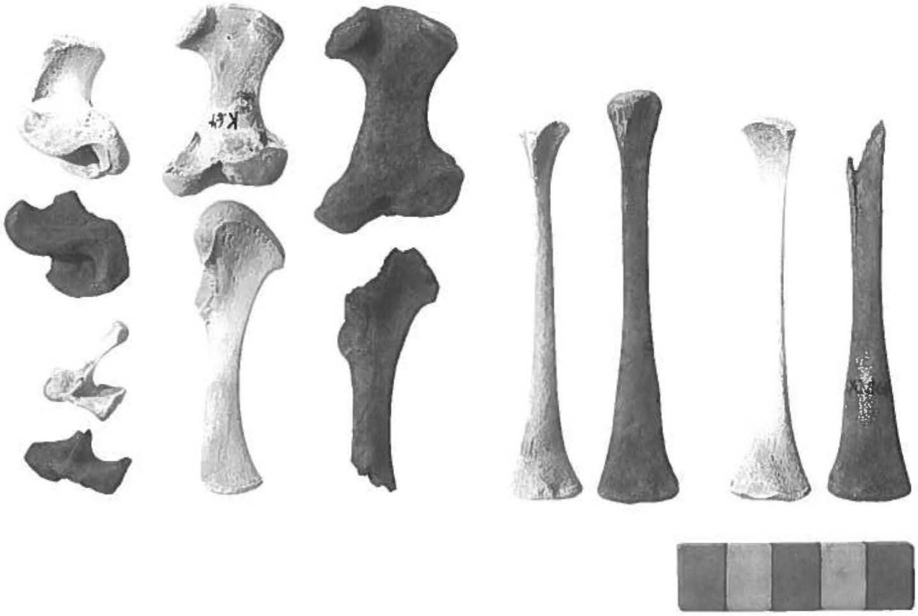


Fig. 13. Bones from juvenile seals, probably common seal, excavated at GUS (dark bones) compared with bones from a recent foetus of common seal. Above left: part of not yet fused cervical vertebra no. 1; below left: part of not yet fused thoracic vertebra; above middle: diaphysis (shaft) of femur; below middle: diaphysis of ulna; right: diaphysis of fibula. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

Fig. 14. Right mandible of juvenile common seal excavated at GUS, compared with mandibles of a 12 days old Recent common seal. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

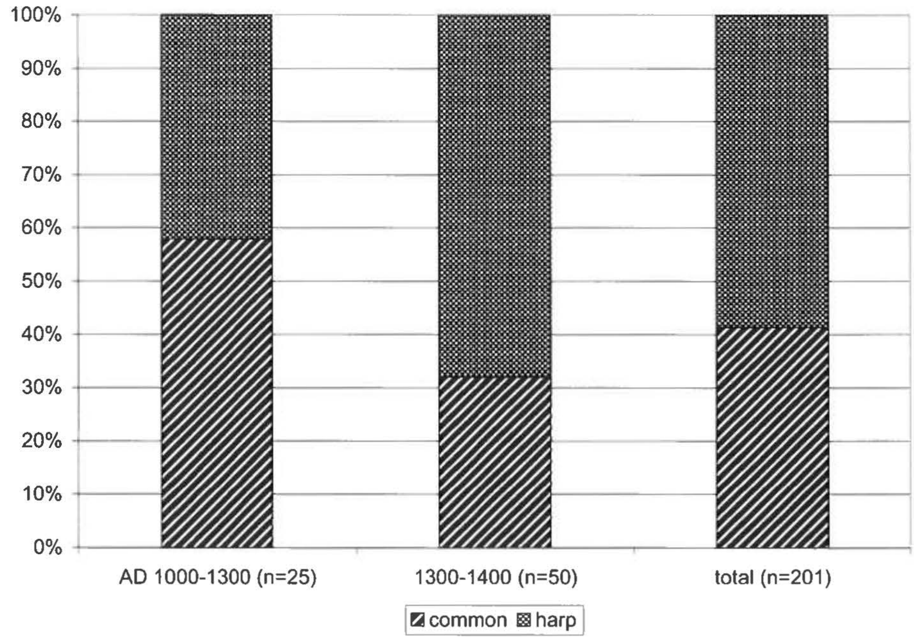


Fig. 15. Relative frequencies of fragments of harp and common seals from GUS in phases 1+2 (AD 1000-1300), phase 3 (AD 1300-1400) and in the total material. Photo: G. Brovad, Zoological Museum.

(McGovern *et al.* 1993) but is not a general rule. For instance, the numerical relationship between harp and common seal shows no clear temporal pattern at Sandnes (McGovern *et al.* 1996).

The single fragment of hooded seal is quite unusual in a Western Settlement context, where this species is usually totally absent. In contrast, it is much more common (more so than common seal) in samples from the Eastern Settlement where it usually is the second most abundant seal species after harp seal (McGovern 1985). Hooded seal is a migratory species, whose routes do not take it close to land in the Nuuk area, but which comes closer to land in the Southwest of Greenland where the Eastern Settlement was situated (Vibe 1990).

The moderate representation of bearded seal is in line with the general pattern in both the West and the Eastern Settlement, as is the rarity of ringed seal (McGovern 1985).

A number of fragments identified to harp seal, common seal, *Phoca* sp. or bearded seal are from not full grown individuals (epiphysal fusion not complete). This observation, however, cannot be used as an indicator of season, because of great variability in epiphysal fusion in marine mammals (Storå 2000).

Summarising, seals constituted a major resource for the GUS people, already from the first phase of inhabitation.

Walrus

There are all in all 51 fragments of walrus, some of which could be referred to phases 1, 2, and 3. All main divisions of the skeleton (head bones, scapula, ribs, pelvis, tail, legs, and os penis) are represented (Tables 5-7), which fits into the general pattern at Western Settlement sites (Degerbøl 1936). In contrast, walrus finds from the Eastern Settlement consist almost exclusively of maxillary fragments, post-canine teeth and os penis (baculum) (McGovern 1992). The maxillary fragments and the teeth are interpreted as remains from a harvest of walrus tusks, which are known to have been an important trade good for the Norsemen. Remains of this tusk trade are most conspicuous at the cheftain's farm, Sandnes, where almost 1500 fragments of walrus bone have been found (McGovern *et al.* 1996).

Os penis has been interpreted as a "trophy" (e.g., McGovern 1992) although this bone might also have been used for toolmaking. Cutmarks on the os penis from GUS show that it has been cut off at its basis.

It is known that the Norsemen went north for walrus-hunting in the Disko Bay area (McGovern 1980), but in the Western Settlement sites, including GUS, fragments of meat-bearing bones (e.g., costae, pelvis, scapula, Fig. 16) are represented in addition to bones representing remains from tusk-collecting and the os penis. Following Degerbøl (1936) this indicates that at least some of the walruses killed in the Western Settlement were killed relatively close to the sites – otherwise the hunters would only have brought the valu-

Fig. 16. Left scapula of walrus, excavated at GUS. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

able tusks and associated parts of the body back home. According to Degerbøl (1936), walrus used to go ashore at several places in the Godthåb (Nuuk) district in former (historical) times, and this was probably also the case during Norse times. The broad representation of the walrus skeleton at Western Settlement sites including GUS thus indicates that meat was eaten by the inhabitants. The tough walrus hide may also have been used for rope-making (Vibe 1990), and the caudal vertebrae and distal limb bones found may have been brought to GUS sitting in hides.

Whales

Twenty-five fragments of whale bones were found, some of which could be referred to phases 2 and 3. In addition a large number of baleen fragments was found. These were not included in the counts but do bear witness of an exploitation of baleen whales at GUS.

Whale bones are difficult to identify to species level, especially when they, as in this case, are mainly represented by small fragments which in many cases cannot even be referred to a specific skeletal element. A few fragments could be recognised as being from calvarium, vertebra lumbalis, vertebra caudalis, costa, scapula and metacarpus.

There are at least three species of whale in the material: 1) Longfinned pilot whale or killer whale, 2) White-beaked dolphin/ or Atlantic white-sided dolphin, and 3) Bowhead whale. Northern right whale may also be present. The two former species are toothed whales, the two latter are baleen whales. Apart from the cosmopolitic killer whale and the circumpolar, arctic Bowhead whale, the mentioned species are visitors from the south in Greenland waters.

Degerbøl (1936) described whale remains from the Western Settlement. He was able to identify, among others, three species which are on the (potential) GUS list: Longfinned pilot whale, White-beaked dolphin and Northern right whale (the latter under the name of *Balæna australis (biscayensis)*).

Three whale vertebrae from GUS (2 lumbar and 1 caudal vertebrae) have been worked. The following details are from Nyegaard (1992):

Find no x 561, found in the weaving room: a lumbar vertebra of Bowhead or Northern right whale. Both transverse processes are cut off like most of the neural arch. There are bowl-shaped excavations on the caudal side of the body of the vertebra. The cranial side seems to have been used as a chopping block or as a cutting board.

Find no. x 631: a caudal vertebra of Bowhead or Northern right whale. The caudal side of the body has a bowl-shaped excavation with an opening in the bottom. (Nyegaard suggests that it might have been used as a chamber pot).

Find no. x 410: one half lumbar vertebra cleft in the midline. The body is excavated like in the two above cases. Chop-marks on the opposite side.

Degerbøl (1936) also reports on "a worked caudal vertebra". The combination of chopping-block-like marks and a bowl-shaped excavation is also known from a vertebra of humpback whale (*Megaptera novaeangliae*) from the Western Settlement site Austmannadal (Degerbøl 1941). According to McGovern (1992), "a common use for the large vertebra of baleen whales was as cutting board or chopping block".

As pointed out by McGovern (1992, McGovern *et al.* 1996), fragments of large whales found at archaeological sites pose special problems of interpretation because the inhabitants might have brought home huge quantities of whale meat while leaving the skeleton behind, in which case there would be no traces left. On the other hand, the inhabitants might have brought home bones from stranded whales without having used the meat at all. The finds of whale remains at numerous Norse sites in Greenland do, however, clearly show that whalebones were widely used. This is evidenced both by the worked whalebones like those mentioned above and by small chips and flakes resulting from the fabrication of tools (McGovern *et al.* 1996).

Reindeer

With 1192 fragments from all phases, the reindeer (caribou) is one of the most prominent mammals in the GUS material, surpassed only by seals and sheep/goat in terms of number of identified fragments.

The relative importance of reindeer seems to decrease over time. They constitute 27% of the mammal fragments in phase 1, 13% in phase 2 and 12% in phase 3, see Fig. 12. The decrease may be ascribed to the natural population fluctuations so typical of reindeer and needs not signify a decision by the GUS people. Data on Greenland reindeer from the last ca. 250 years indicate fluctuations with a period of ca. 65 to ca. 115 years and with peak population sizes more than ten times the minimum numbers (Meldgaard 1986).

Age estimates

The bone collection from GUS includes a number of more or less complete reindeer mandibles, some of which have been fractured for marrow extraction (Fig. 17). All permanent teeth have erupted in the available mandibles, and age estimates may therefore be made only on the basis of tooth wear.

Age was estimated by studying patterns in the relationship between exposed enamel and dentin and comparing with series of recent mandibles from reindeer of known age. The recent mandibles were collected in the Sisimuit (Holsteinsborg) area in West Greenland, *i.e.*, in the same general area as GUS, and kept in the collections of the Zoological Museum, University of Copenhagen. In order to facilitate comparison with other studies, age was also estimated according to the criteria suggested by Miller and Spiess (see Grønnow *et al.* 1983). See Table 12.

The degree of dental wear depends, *i.a.*, on the nature of the food taken in by the reindeer, and on the amount and nature of dirt on the food plants.

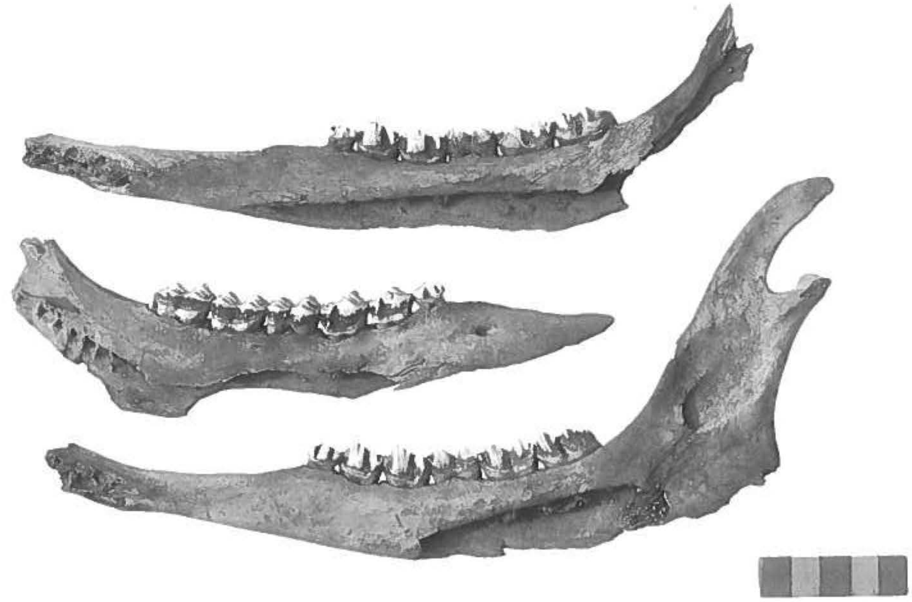


Fig. 17. Three right mandibles of reindeer excavated at GUS, showing fractures from marrow extraction. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

Dental wear methods are thus subject to some uncertainty. Mainland (2001) studied microwear on sheep teeth from two Norse sites in Greenland and concluded that the diet of the Norse sheep had included high levels of soil/grit. The possibility that not only sheep, but also reindeer from GUS, ingested high levels of soil/grit should therefore be borne in mind and would result in an over-estimation of age based on dental wear.

Based on the comparison with recent Sisimuit reindeer, two of the individ-

GUS sample no.	left/right	teeth present	age (years) by comparison with recent mandibles	age (years) according to Grønnow et al. (1983)
x 774	right	P_2,P_3,P_4,M_1,M_2,M_3	ca. 4½	2.3-5
x 1821	left	P_2,P_3,P_4,M_1	4½-5½	2.3-5
x 2104	left	P_2,P_3,P_4,M_1	ca. 5	2.3-5
x 2950	right	M_1,M_2	2-3	2.3-5
x 2952	left	P_2,P_3,P_4	ca. 10	> 10
x 2987	right	all	ca. 5	2.3-5
x 3066	right	all	ca. 4½	2.3-5
x 3074	left	P_2,P_3	ca. 5	2.3-5
x 3371	left	P_2,P_3	ca. 3	2.3-5

Table 12. *Age estimation of reindeer from GUS, based on mandibles. Age was estimated by comparison with two series of recent reindeer mandibles from West Greenland, and also by applying the criteria of Miller and Spiess (Grønnow et al. 1983).*

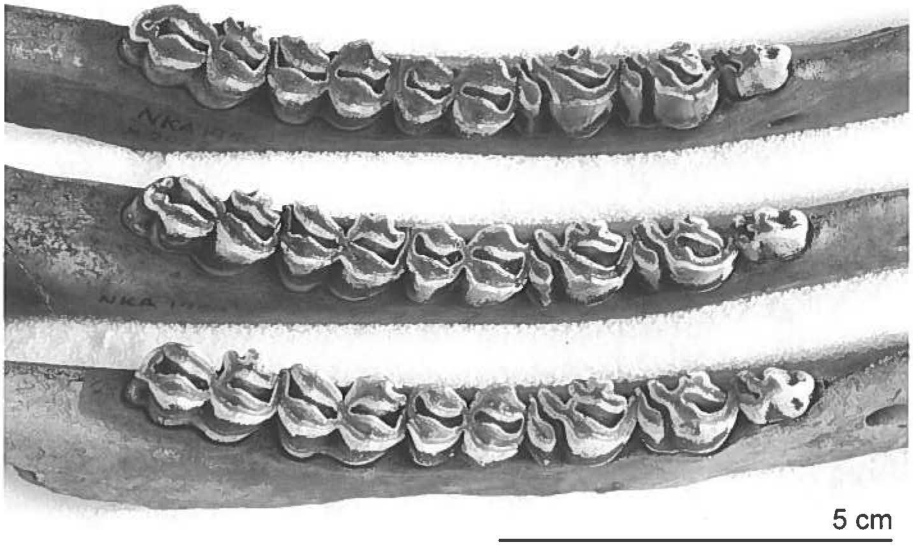


Fig. 18. Three right mandibles of reindeer excavated at GUS (find nos x 774, x 2987, x 3066). The age of these reindeer (see Table 12) is typical of the site. Scale 5 cm. Photo: G. Brovad, Zoological Museum.

uals from GUS died at an age of 2-3 years, six reached 4-6 years and one (find no. x 2952), 10 years. The criteria cited by Grønnow *et al.* (1983) referred all mandibles but one to the age group 2.3-5 years (Fig. 18), the last (x 2952) was estimated to more than 10 years. It would thus seem that of the reindeer killed at GUS, the majority were adult, a few were old, and at most very few were young.

This conclusion is supported by an alternative method for age estimation, viz., a study of epiphysal fusion. Only about 70 of the 1192 reindeer fragments from GUS indicate unfused epiphysis, so on a general level, this criterion supports the impression gained from the study of mandibles: that the reindeer remains from GUS are largely from adult individuals.

Hufthammer (1995) studied the timing of epiphysal fusion in reindeer. Of the group with the earliest epiphysal fusion after birth (scapula, radius, humerus) all bones from GUS show fused epiphyses. The next group, in which fusion takes place at an age of 6 to 18 months, consists of phalanges 1 and 2 (proximal epiphysis). The GUS material contains 7 fragments of reindeer phalanges 1 and 2 where epiphysal fusion has not yet happened (out of a total of 28 phalanges 1 and 2). These 7 fragments would be from reindeer of an age no higher than 18 months. The remaining reindeer bones with unfused epiphyses belong to categories where fusion takes place at an age above 18 months (some epiphyses do not fuse until the fourth or even fifth year).

The more detailed study of epiphysal fusion still supports the impression of very strong dominance of adult (but generally not very old) reindeer in the GUS material, although a minor element of juveniles cannot be excluded.

	phase 1 (AD 1000-1150)	phase 2 (AD 1150-1300)	phase 3 (AD 1300-1400)
reindeer	32 / 35 = 0.91	18 / 7 = 2.57	79 / 68 = 1.16
sheep + goat	38 / 24 = 1.58	26 / 36 = 0.72	105/ 192 = 0.57
cattle	6 / 20 = 0.30	3 / 16 = 0.19	9 / 39 = 0.23

Table 13. *Ratios of numbers of meat-rich upper limb bones (humerus, radius, ulna, femur, tibia) to numbers of relatively meat-poor lower limb bones (metacarpales, metatarsales, phalanges) in reindeer, sheep/goat and cattle from GUS. See also Fig. 19.*

Evidence for reindeer hunting

The absence, or at least rarity, of juvenile individuals indicates that the reindeer from GUS are wild ones, which were hunted. If the Norsemen had kept herds of reindeer, one would have expected to find many remains of butchered juvenile and subadult individuals (Hambleton and Rowley-Conwy 1997).

Further support for this conclusion comes from the ratio between "meat-rich upper limb bones" (humerus, radius, ulna, femur, tibia) and "relatively meat-poor lower limb bones" (metacarpals, metatarsals, phalanges), cf. McGovern *et al.* (1996). Unlike the domestic mammals, the assemblage of reindeer bones from GUS shows a strong predominance of the former group (Table 13, Fig. 19), suggesting that meat-poor parts of the body were left on the hunting grounds.

Nowadays, the area around GUS is a good hunting ground for reindeer, actually the site was discovered in 1990 by reindeer hunters.

Arctic hare

No less than 125 fragments of Arctic hare were recovered, covering phases 1, 2 and 3, see Fig. 20. This is quite a high number in comparison with other Norse sites (McGovern 1985) and is probably a consequence of the meticulous excavation routine followed at GUS. The fact that even tiny bones like tarsals, metacarpals, metatarsals and loose teeth were found does indeed testify to this. Many of the hare bones were found in sieved samples. Systematic sieving would no doubt have resulted in even more fragments of the fragile hare skeleton, and the hare probably played a more prominent role at GUS than suggested by the mere fragments numbers.

One of the finds is constituted by six-and-a-half connected vertebrae (the posteriormost thoracic + 6 lumbar vertebrae, the thoracic vertebra is cut obliquely through). This might well represent remains from a meal. There are also cutmarks on a number of other hare bones.

Degerbøl (1936) noticed a comparatively high number of hare bones from

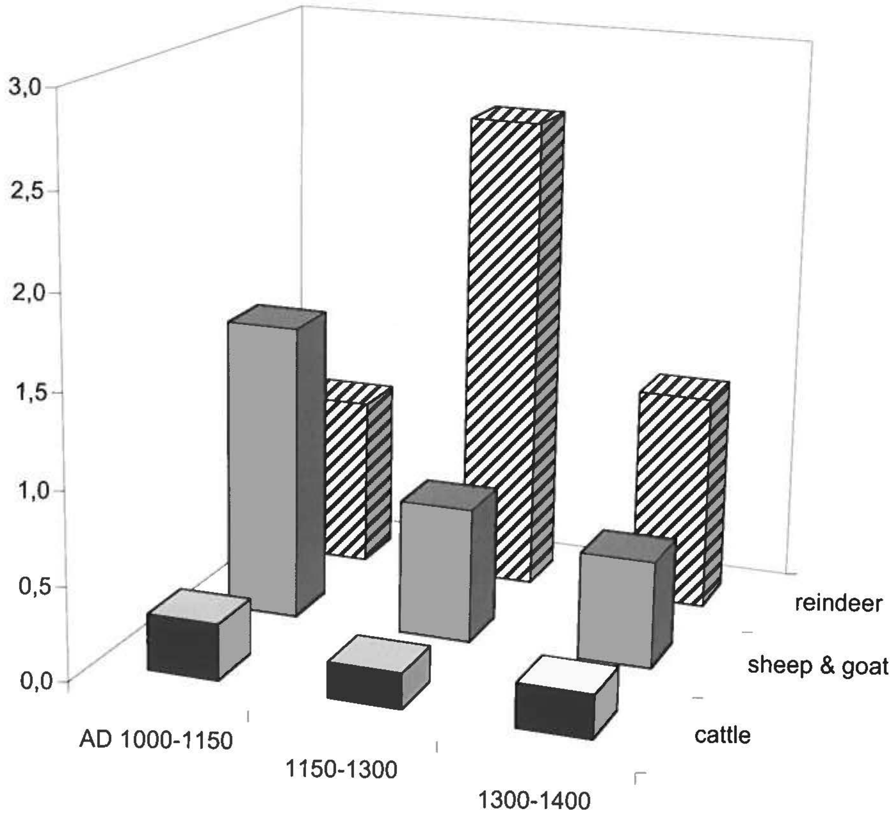


Fig. 19. Ratios of numbers of meat-rich upper limb bones (humerus, radius, ulna, femur, tibia) to numbers of relatively meat-poor lower limb bones (metacarpales, metatarsales, phalanges) in reindeer, sheep/goat and cattle from GUS. See Table 13 for absolute numbers.

Western Settlement sites, in contrast to Eastern Settlements ones from where only a single hare bone was known by then. Later, McGovern (1992) found only two hare bones in the large material from the Eastern Settlement site Ø71. Relatively many (59) hare bones are known from the neighbouring farm Nipaatsoq (McGovern 1985). Maybe this is a reflection of higher abundance of hare near inland sites? According to Vibe (1990) the arctic hare is scarce at the low exterior coasts, whereas is occurs all the way down to the fjords in the inland, although it mostly stays at somewhat higher altitudes.

In addition to meat, the Norsemen exploited the fur of the arctic hare. For instance, the white hairs were used in weaving for adding white stripes to brown textiles (Østergaard 1998).

Arctic fox

The single remain of arctic fox found at GUS is a broken mandible from phase 3, found in a sieved sample. The low number of fox fragments, compared to the number of fragments of hare, which is also a small species, may be due to

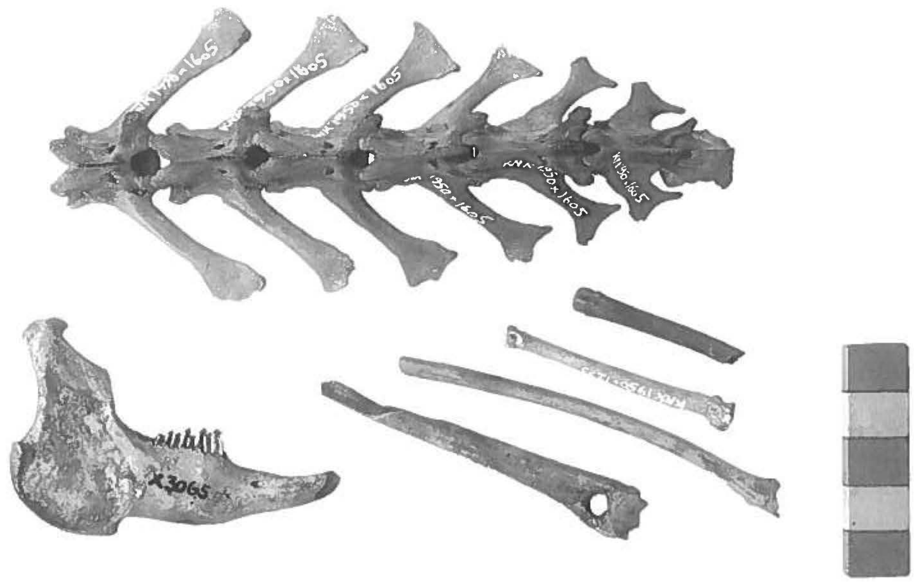


Fig. 20. Bones from Arctic hare excavated at GUS. The Arctic hare constitutes a constant element of the meals at Gus through time. Above: six-and-half connected vertebrae; below from left: one mandibula, one humerus, one radius, two metacarpale/metatarsale. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

the fact that hare, unlike fox, was a meat source, and that its bones therefore stood a better chance of ending up among the kitchen refuse. Norse sites in Greenland do generally have only few remains of fox (Degerbøl 1936; McGovern 1985).

Polar bear

There are three fragments of polar bear, referred to phases 2 and 3: – The anterior, severed part of the two fused mandibles, with the canine teeth still *in situ*, and with ornaments along the jaw and at the tooth alveoli (phase 3) – One mandibular canine tooth, with cutmarks (phase 3) – One maxillary canine tooth with marks looking as if the tooth has been chopped out of the jawbone using a chisel (phase 2).

It is a general picture that there are only few fragments of polar bear at Norse sites (Degerbøl 1936; McGovern 1985). The fragments found at GUS may derive from stray bears killed near GUS, or from individuals brought in from hunting grounds to the north, e.g., in the Disko Bay area where also walrus was hunted (McGovern 1980, 1985). At other Norse sites, phalangal and metacarpal bones of polar bear have often been found. These might have been sitting in bear furs, which are regarded as having been an important export article for the Norsemen (McGovern 1980, 1985, 1992).

Fishing

The bone material from GUS includes 166 fragments of fish bones, plus remains of a mummified sculpin, see Tables 4, 10. This is a very large number of fish bones for a Greenlandic Norse site. The largest find reported by McGovern (1985) and McGovern *et al.* (1996) consists of a mere 14 fish bones. The fish bones from GUS only represent phases 2 and 3, and no significant differences between these phases are evident.

In addition to the sculpin there are bones from arctic char, capelin, cod, threespined stickleback and halibut.

Most of the fish bones are from salmonid fishes (96 fragments), including arctic char and capelin. In addition there are a fair number of fragments of cod (31 in total, but this includes 26 fragments representing one fish tail). The remaining species on the list (threespined stickleback, sculpin and halibut) are each represented only by a few bones, see Fig. 21.

Recovery and preservation of fish bones

Almost all fish bones were found by sieving of sediment. This proves the importance of this excavation technique for recovering the often very small

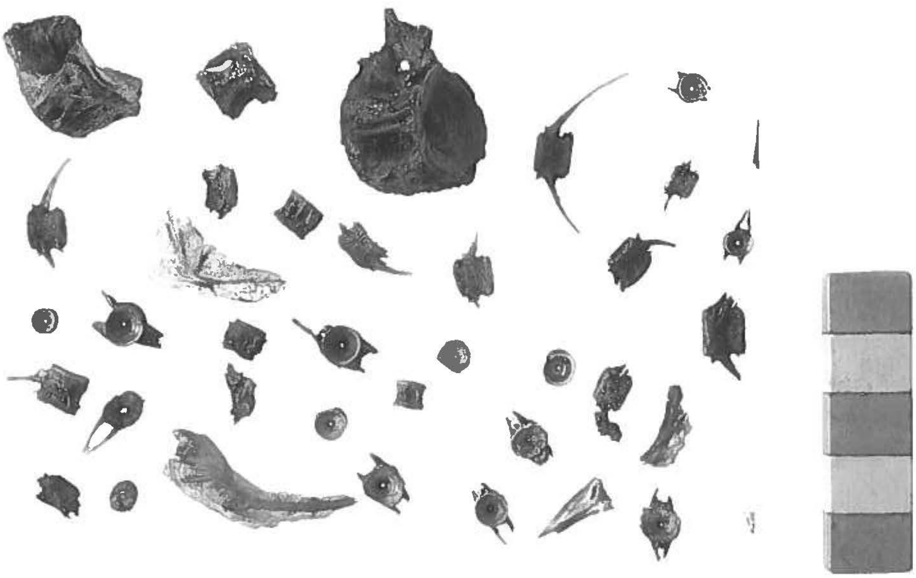


Fig. 21. Some of the fish bones found at GUS. Upper left: two vertebrae of cod; upper middle: one vertebra of halibut; below right: one tiny dentale of capelin. The rest of the bones are from Arctic char, mostly vertebrae but also, e.g., one cleithrum (slightly to the left of center) and one praeoperculum (number three from left in lowermost row). Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

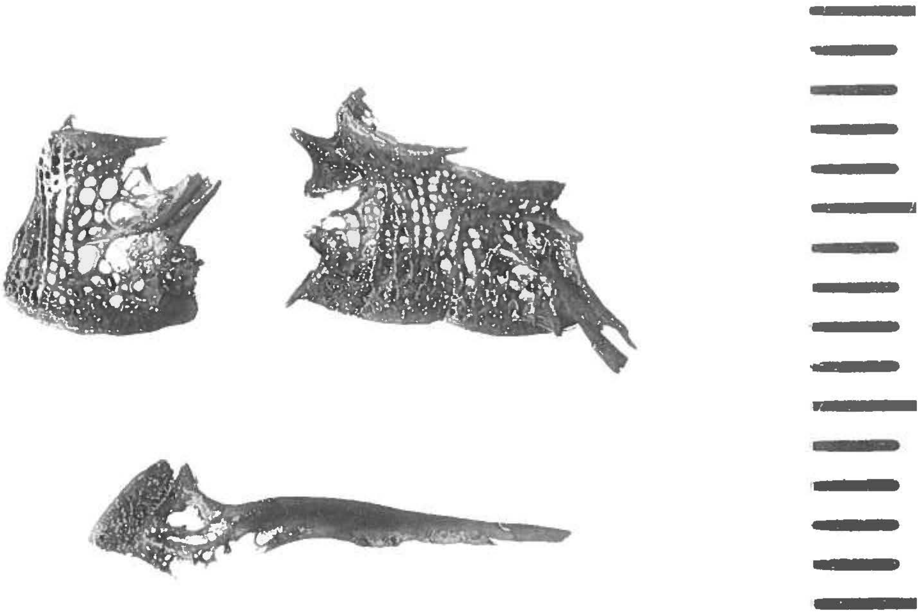


Fig. 22. Fragments of three vertebrae of Arctic char excavated at GUS. The vertebrae are preserved merely as a thin mesh of the porous structure. Scale units 1 mm. Photo: G. Brovad, Zoological Museum.

fish remains. A few tiny bones of capelin were found in sediment adhering to mammal bones. The state of preservation of the fish bones is variable. Many of them appear to be well preserved but are fragile, having a tendency to disintegrate into lamellae – this is especially true of cranial bones. The construction of fish bones is different from that of mammal and bird bones, fish bones having a more lamellar structure. Repeated freezing and thawing may easily cause the lamellae to separate. A few of the salmonid vertebrae are preserved merely as a thin mesh representing remains of the porous structure on the sides of the vertebra (Fig. 22). These observations suggest that the small number of recovered fish bones is in part caused by the excavation technique and conditions of preservation. It is however, worth noticing that considerable numbers of fish bones have been recovered from some palaeo-Eskimo sites (e.g. Godtfredsen 1998).

Bones of salmonid fishes have particularly poor chances of preservation, since they are of a more cartilaginous nature than bones from most other fishes. The dominance of salmonid bones in the GUS material may thus indeed be an under-representation of the actual relative importance of salmonids.

Notes on identification

Sculpin – The mummified sculpin is represented only by the posterior half. Since the anterior end with the species specific head bones is missing, identification to species level is impossible (Greenlandic waters house a large variety of sculpin species).

Cod – The sheer size of the gadid vertebrae (cf. below) excludes the Greenland cod (*Gadus ogac*), which is very similar to cod but only grows to maximally 65 cm (Nielsen and Bertelsen 1992). The gadid tail represented by 26 fragments can also be identified to cod based on a combination of size and morphological characters.

Representation of fish bones

Bones from both head and body are present from the most frequent species: arctic char and capelin. Head bones are missing from the other species, but considering the low number of fragments, this may be due to chance alone.

Size of the fish

The fragments of cod are from large individuals, the two identified vertebrate coming from cod with a total length of ca. 85 cm, and one from an even larger cod, ca. 1 m. The cod tail mentioned above comes from a fish 80-100 cm long.

By simple comparison with recent skeletons, the bones of arctic char are estimated to be from inviduals of a total length of about 50 cm. The diameter of the two halibut vertebrae is about twice as large as that of a vertebra from a 55 cm long individual and thus must have belonged to a large individual.

Biology of fish species

The following information on the biology of individual species as well as on conditions in Greenland fjords has been extracted from Muus (1990).

The cod occurs along the westcoast of Greenland from Disko Island southwards. The occurrence of cod is of a periodical nature, the cod population typically flourishing when sea temperature raises (Muus 1990). The Norsemen arrived to Greenland during a warm period, so cod should have been abundant during most of the period of Norse occupation. Arctic char occurs in rivers and in the sea near the coast in Greenland (Nielsen and Bertelsen 1992). Capelin is abundant along the westcoast of Greenland as far north as Umanak (Muus 1990). Three-spined stickleback is very common along the Greenland westcoast as well as in brackish water, rivers and lakes (Muus 1990). Halibut is common along the westcoast and also enters the fjords.

All the fish species found at GUS are thus common along the Greenland westcoast nowadays. The Ameralik Fjord is a cold threshold fjord. In the deep threshold fjords the bottom water is cold throughout the year and the fish fauna is dominated by arctic species, e.g. Polar cod (*Boreogadus saida*). In contrast, the warm Atlantic water can penetrate fjords with a deep mouth (no threshold), e.g. the Godthåb Fjord. Such fjords are dominated by boreal species such as cod and halibut. Arctic char and sculpins are so-called boreo-arctic fishes, occurring in both boreal and arctic waters.

Discussion of fish

Although fish bones from GUS are not very plentiful, this material is the largest fish bone material recovered from Norse sites in Greenland so far. McGovern (1985) thus demonstrated the very low numbers of fish bones from sites in the Eastern and Western Settlements.

When interpreting this fish bone assemblage, it should be borne in mind that bones of small fish like capelin might represent stomach contents of larger fish, seabirds or seals. However, the seals caught by the GUS inhabitants seem to have been eviscerated before being brought home, in which case their stomach contents would not have left traces in the GUS material (cf. p. 32).

The tiny capelin bones (Fig. 23) may very easily be lost during the recovery process: they will only be retained by the finest mesh, and even those which are retained may not be recognised as fish bones. Furthermore, when eating capelin, the bones are in most cases ingested together with the meat and will thus not end up in the kitchen refuse (cf. Vebæk 1991). Fish or fish refuse may also have been fed to the dogs. This would further diminish the number of fish bones in the refuse. In fact, isotope analyses have revealed that dogs are often more marine than their masters (Arneborg *et al.* 2002).

Capelin is known to occur in enormous quantities on shallow water during the spawning season (May-July) and may even strand on the beach. They can thus easily be harvested with shovel and bucket. Capelin has been an important source of food throughout the history of Greenland, both for humans and for domestic animals (sheep) (Muus 1990).

There is no doubt that fish, including capelin, have formed part of the menu of the Norsemen. From the neighbouring site Nipaatsoq, Møhl (1982) thus identified skeletons of three capelins and one cod from among remains found in a pantry. A large iron hook, which would have been suited for catching large fish like cod and halibut, was found in layers from the latest settlement period of the eastern settlement site Narsaq (Hans Kapel, pers. comm.). Vebæk (1991) reported finds of netsinkers and fishing hooks as further proof of fishing in Norse Greenland.

In stark contrast to the conditions at the Western Settlement, large finds of fish bones are known from Norse sites in Iceland, the Shetland and Orkney Islands, northern Scotland and Norway (Amorosi *et al.* 1994; Barrett 1995; 1997; Barrett *et al.* 1999; Buckland *et al.* 1996; Nicholson 1998; Tinsley in press). Fishing may therefore have been relatively much more important in these places than in Greenland. The dominance of salmonid bones seen at GUS reminds of the situation at the Icelandic sites (Tinsley in press).

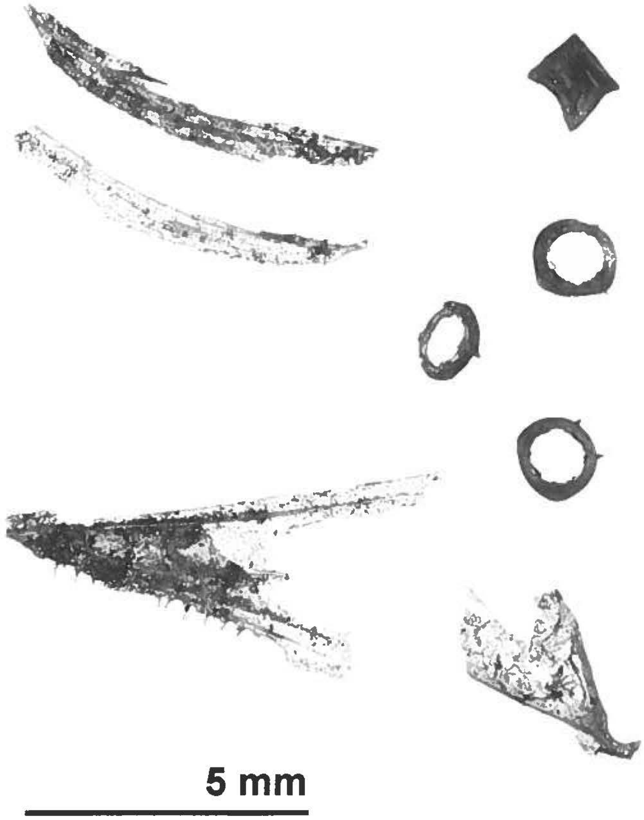


Fig. 23. Bones of capelin excavated at GUS. Above left: two maxillaries; above right: four vertebrae; below left: one dentary; below right: one articulare. Scale 5 mm. Photo: G. Brovad, Zoological Museum.

The fishes from GUS include boreal and boreo-arctic, but no arctic species. A possible interpretation of this species spectrum could be that the people at GUS caught their fish at the ocean coast or in the Godthåb Fjord (which has no threshold). As a counter-argument against this hypothesis, one may mention that during the months of June and July, the cod often raise closer to the surface where the water is warmer, because cold polar water floods the banks. During this pelagic phase cod may penetrate threshold fjords. L. Heilman (pers. comm.) thus informs that nowadays there is big cod in the inner parts of the Ameralik Fjord. They arrive during springtime together with the capelin and disappear again towards autumn. In Itilleq, which is a northern arm of the Ameralik Fjord, cod as large as 110 cm may be caught, and similarly large cod might well have been available in the Ameralla Fjord. The fish may also have been caught in river mouths where arctic char is often plentiful. Cod as well as halibut tend to seek out such places to feast on the char. This interpretation of the fishing at GUS would fit with the dominance of arctic char in the material. The other species, cod, halibut etc., would have constituted a supplement to the main target species.

Although the number of cod bones is small, the large size of the individuals in question, coupled with the absence of head bones from cod, might suggest a production of cured cod (see Brinkhuizen 1994; Barrett 1997). At the Icelandic site Hofstaðir, Tinsley (1999) also found no head bones of cod although of salmonids the whole skeleton was represented.

Animal husbandry: domestic mammals

Sheep and goats

The small ruminants, sheep and goat, sometimes collectively referred to as caprines, provided the second-largest number of bone fragments from GUS, only surpassed by the seals. There is a weak tendency for sheep/goats to gain in importance through time at GUS (Fig. 12). No less than 2156 fragments could be referred to this group, not counting a complete goat skeleton (see below).

Particular care was taken to distinguish bones of sheep and goat as far as possible at all. In addition to the large reference collection of the Zoological Museum, University of Copenhagen, the works of Boessneck *et al.* (1964) and Prummel and Frisch (1986) were used. Nevertheless, only 225 fragments could be identified with certainty as deriving from sheep, 189 from goat. The majority of fragments of the sheep-goat group (81%) could not be identified to species level.

Age structure of sheep/goat from GUS

Age of sheep/goats was estimated on the basis of tooth eruption and wear. Fig. 24 shows the age distribution based on mandible wear stage (M.W.S.) according to Grant (1982). Fig. 25 provides supplementary age estimates

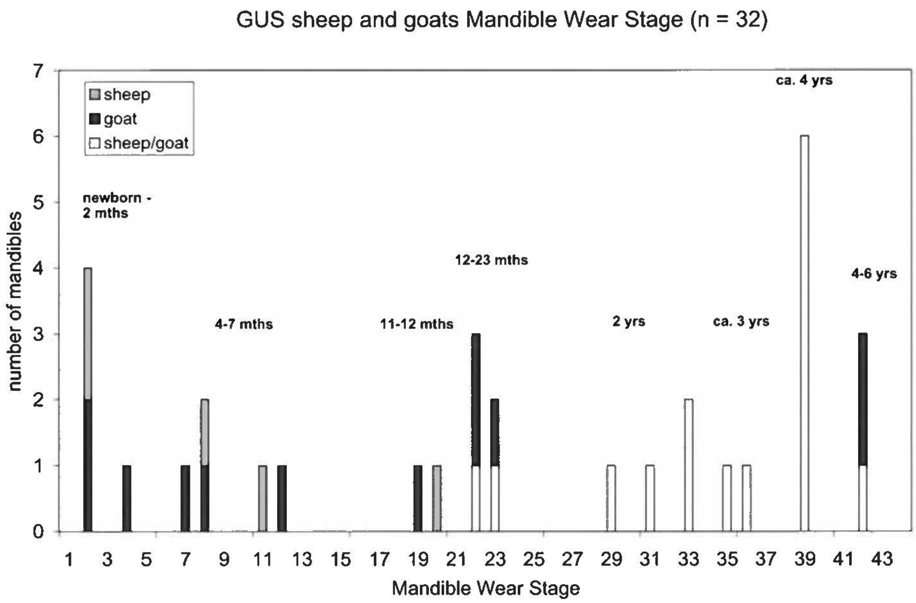


Fig. 24. Age distribution of sheep/goat from GUS based on mandible wear stages sensu Grant (1982).

based on wear patterns (T.W.S.) for individual, mandibular dp_4 and M_3. Fig. 25 contains information from loose (not shed) dp_4 and M_3 as well as those still *in situ* in the mandibles. The evidence from the three diagrams is thus in part overlapping. The age classes (months and years) shown on Figs 24-25 are based on a comparison with mandible and tooth wear stages in a collection of Recent Gotland sheep (Zoological Museum, University of Copenhagen)

Only juvenile mandibles with dp_4 still *in situ* were identified to sheep or goat. The two adult mandibles identified to goat in Fig. 24 are those belonging to the complete goat skeleton (see below). Based on the occurrence of sheep and goats among the youngest age classes in Fig. 24, more young goats than lambs seems to have been slaughtered (notice, however that numbers are small and therefore only indicative).

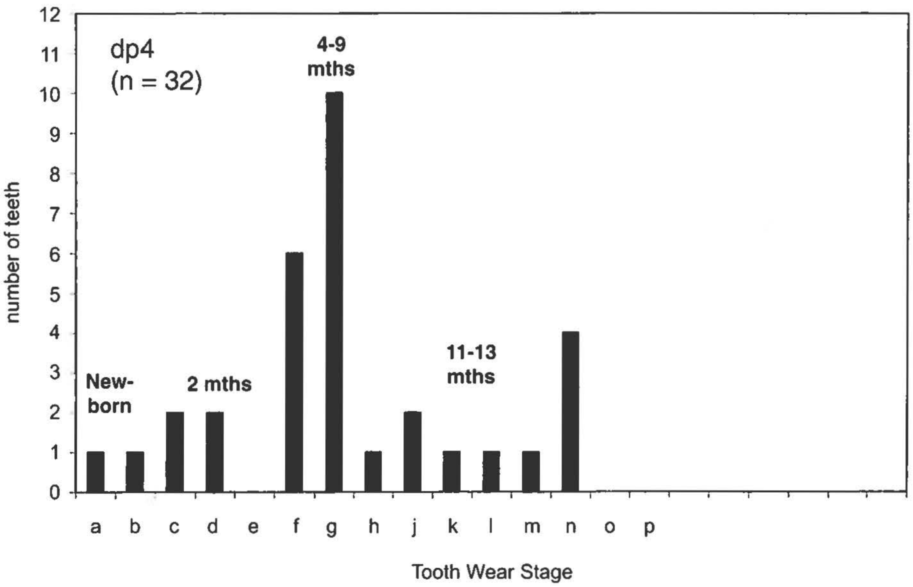
A frequency diagram like Fig. 24 may be transformed to a "survivorship curve". Payne (1973) described three ideal survivorship curves for sheep and goats, one for a milk-based, one for a meat-based and one for a wool-based production. In a milk-based production, many very young (mainly males) are killed, and the survivorship curve therefore shows a sharp initial drop. If wool is the main product, comparatively many sheep are allowed to reach a high age – the curve is therefore quite flat. For a meat-based production, the curve lies between the milk- and wool-based ones, showing quite a steady decrease, although the main kill can be seen to take place in age classes D-E.

The age groups marked on Fig. 24 were translated to Payne's age groups A-G:

"newborn – 2 mths"	~ A,
"4-7 mths"	~ B (for Payne, the upper limit of group B is 6 months),
"11-12 mths"	~ C,
"12-23 mths" and "2 yrs"	~ D,
"ca. 3 yrs"	~ E,
"ca. 4 yrs"	~ F,
"4-6 yrs"	~ G.

It should be noted that Payne (1973) used another method for estimating age, and that alternative assignments of my age groups to Payne's categories could be devised.

The survivorship curve for GUS sheep/goats (Fig. 26) most resembles the meat-based one. On the other hand, in a situation like that at GUS: a relatively small household in a relatively tough environment, one would expect the Norsemen to have exploited all three products: milk, meat and wool. There is ample evidence that sheep's wool as well as goats' hair was used extensively for textiles by the inhabitants at GUS throughout the 350 years GUS was inhabited (Østergaard 1998), and in the cold climate, access to wool and hair must have been of prime importance.



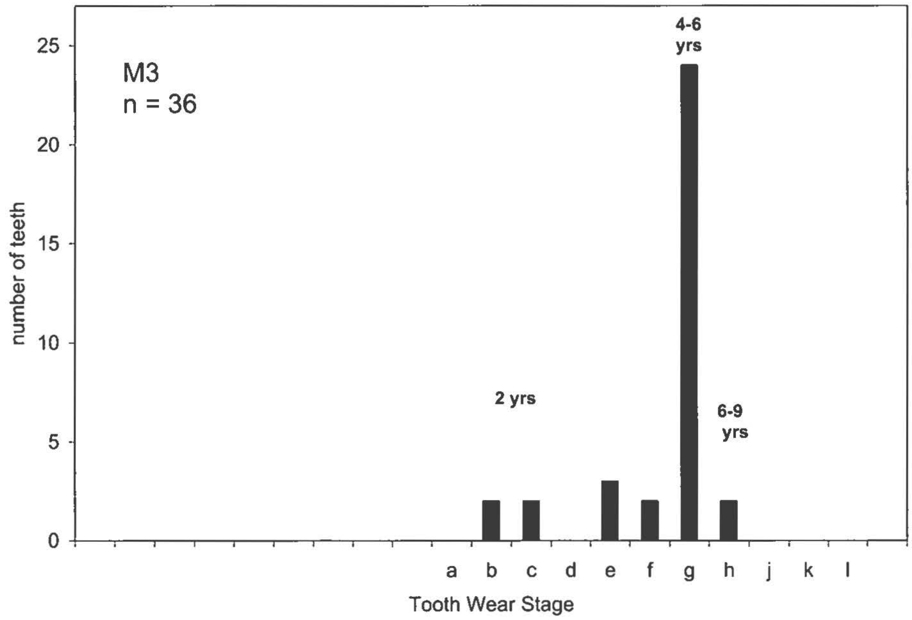


Fig. 25. Age estimates for sheep/goat from GUS based on wear patterns sensu Grant (1982) for individual, mandibular dp_4 *and* M_3.

One difference between the GUS survivorship curve and Payne's model one is that at GUS' survivorship reaches zero at a much earlier stage than in any of Payne's curves. However, Payne's models were based on modern case studies, and a lack of older animals is not uncommon in archaeological assemblages (Rowley-Conwy 2000).

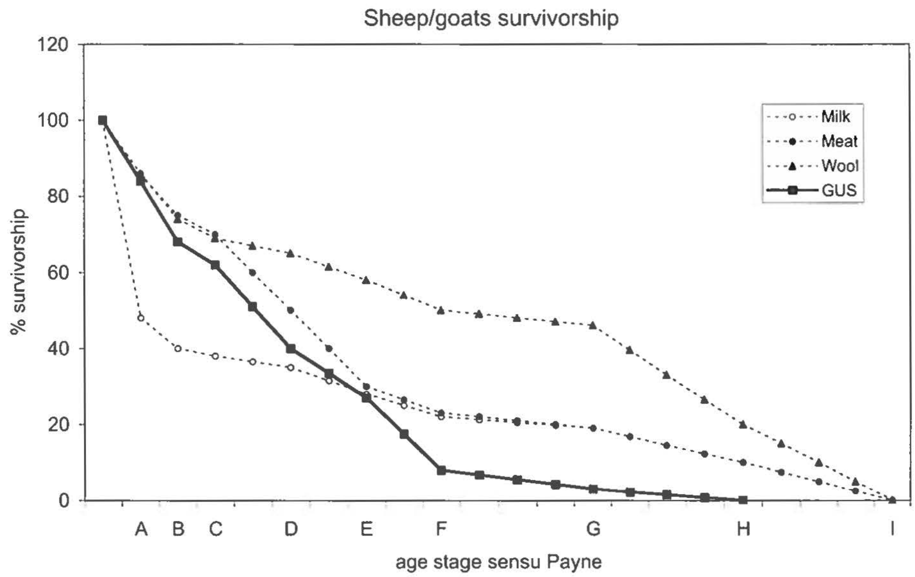


Fig. 26. "Survivorship curve" sensu Payne (1973) for sheep/goats from GUS, based on the age distribution shown in Fig. 24, see text. Payne's ideal curves for milk-, meat- and wool-producing husbandry of sheep are also inserted.

One additional factor may indeed amplify this difference: Mainland (2001) showed that tooth wear in Norse sheep from Greenland was affected by soil/grit in the food. The same phenomenon has been noticed in sheep/goats (and pigs) from Iceland (Tinsley 2001). Using tooth wear as a criterion in such cases may therefore overestimate the actual age. That accelerated tooth abrasion may actually have taken place at GUS, is tentatively indicated by the slightly lower age estimations for the complete goat obtained using epiphysal fusions, when compared with estimates based on tooth wear (see below).

Finally, age estimates based on individual teeth (dp_4 and M_3, Fig. 25) provide additional information indicating that the age distribution based on entire mandibles (Fig. 24) may not be quite representative. The age distribution indicated by individual dp_4 shows very few individuals in the youngest age classes, but a peak of individuals in the age 4-9 months. Of the individuals aged by means of M_3, the majority belongs to the 4-6 years class. If the age distributions based on these two teeth could somehow be combined with that based on mandible wear stages, the survivorship curve would be displaced to the right, perhaps coinciding even more with Payne's meat-based curve. Maybe there would even be a "hump" of relatively old individuals, the curve thus approaching the wool-based model.

Sheep size and proportions

Measurements were taken of metapodials (metacarpals and metatarsals) for estimates of size and proportions (robustness) of the GUS sheep. Due to the

GUS sample no.	Phase no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 4.89)
no context	–	2.14	2.40	1.31	0.99	11.90	58.19
x 1278	3	2.40	2.66	1.47	1.10	12.70	62.10
x 1603	3		2.66				
x 1610	–		2.3		1.03		
x 1883	–		2.71	1.48	1.03	ca.12.1	ca.59.17
x 2284	3		2.50		1.00		
x 2418	3	2.34	2.78	1.59	1.09	12.46	60.92
x 2521	3		2.38				
x 2713	–	2.12	2.34	1.25	0.92	11.83	57.85
x 2922	–		2.54		1.09		
x 3107	3	2.10	2.40	1.36	0.94	11.70	57.21
x 3108	3	2.12	2.44	1.30	0.97		
x 3122	1	2.35	2.64	1.54	0.94	11.48	56.14
x 3374	–		2.30		1.12		
x 3386+ 3124	2		2.34				
x 3518	–	2.17	2.44	1.39	0.99	11.82	57.80

Table 14. *Sheep from GUS, measurements of metacarpals according to von den Driesch (1976) and estimates of height at withers according to Teichert (1975). All measurements are in cm. Average height at withers = 58.67 cm.*

high degree of fragmentation of the GUS bone material, the number of measurable metapodials was quite low.

Based on the greatest length of metapodials, the height at withers was estimated using the factor for "ur- und frühgeschichtliche Schäfe" (pre- and early-historical sheep) of Teichert (1975), see Tables 14, 15. Estimates from metacarpal and metatarsal measurements range from 56-62 cm and 53-67 cm, respectively. The sheep at GUS were thus quite small, as was also the case at other Norse sites in Greenland. Although the sample size from the Eastern Settlement is small, there is, however, an indication that sheep from the Eastern Settlement were somewhat larger than those from the Western Settlement. Contemporaneous sheep from Denmark were generally larger than those from Greenland as were contemporaneous sheep from most sites in Iceland (Table 16). A decrease in size over time is indicated at the two Danish sites Århus Søndervold and Næsholm, but the number of metapodials from GUS which could be referred to a temporal phase is unfortunately too small to reveal such a possible tendency. Russell (1985) made an extensive study of sheep in the North Atlantic area and emphasised, e.g., the variability of sheep size in Iceland, sheep from northerly sites being smaller than those from the south of Iceland. The tentative size difference between sheep from the Greenlandic Western Settlement and the more southerly Eastern Settlement mentioned above would fit into this pattern.

GUS sample no.	Phase no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 4.54)
x 83	3	–	2.48	–	1.06	–	–
x 544	3	–	2.31	–	–	–	–
x 716	–	–	2.26	–	–	–	–
x 1243	3	–	2.07	1.14	0.88	11.59	52.62
x 1703	–	2.00	2.33	1.20	1.10	13.08	59.38
x 2289	3	2.08	2.44	1.31	1.08	13.57	61.61
x 2537	–	1.81	–	0.91	0.79	–	–
x 2657	2	1.95	–	1.17	–	–	–
x 2658	1	2.03	ca. 2.32	1.19	1.01	–	–
x 2713	–	2.00	2.47	1.32	1.10	14.66	66.56
x 2858+ 3009	2	2.13	–	1.24	–	–	–
x 3065	–	1.98	2.34	1.22	1.02	13.68	62.11
x 3122	1	–	2.25	–	0.93	–	–
x 3200	2	2.15	ca. 2.47	1.11	1.05	13.24	60.11
x 3447	1	1.86	2.19	1.14	0.85	12.82	58.20

Table 15. *Sheep from GUS, measurements of metatarsals according to von den Driesch (1976) and estimates of height at withers according to Teichert (1975). All measurements are in cm. Average height at withers = 60.08 cm.*

In the scatter diagrams, Figs 27-28, greatest length and smallest diameter of sheep metapodials from GUS are illustrated together with corresponding measurements from other Norse sites in Greenland (Western and Eastern Settlement) and from contemporaneous sites in Iceland and Denmark. These diagrams illustrate size and proportions at the same time.

Greatest length (GL) is a measurement of size (height at withers). The symbols representing GUS material tends to be situated in the left portions of the diagrams, reflecting the small height of the GUS sheep (cf. above).

Robustness of the metapodials, and hence, by inference, of the sheep as such, is illustrated by the ratio between smallest diameter (SD) and greatest length. Robust metapodials occupy positions in the upper left part of the diagram. The overall pattern is that the GUS sheep, together with sheep from other Norse sites in Greenland, form a "robust" group, as opposed to the more finely built sheep from contemporaneous Denmark (Hatting 1998). The individuals from contemporaneous Icelandic sites roughly fall between the "Greenlandic" and "Danish" parts of the diagram. See also Figs 29-30. The robustness of the Greenlandic Norse sheep was pointed out by Degerbøl (1936) who interpreted the phenomenon as "possibly an adaptation to life in a more mountainous country" (see also Hatting 1982). Taking a closer look at the Greenland material alone, the GUS sheep agree with sheep from other sites in the Western Settlement. The few measurements from the Eastern Set-

Locality	dating, AD	metacarpus GL, range	metacarpus GL, average	metatarsus GL, range	metatarsus GL, average	height at withers, range	height at withers, average	n
GREENLAND:								
GUS	ca. 1000-1400	11.48-12.70	12.00			56-62	59	8
do.	do.			11.59-14.66	13.23	53-67	60	7
Western Settlement	ca. 1000-1360	10.8-12.9				53-63	59	14
do.	do.			12.0-15.3		55-70	60	13
Eastern Settlement	ca. 1000-1450	12.4-13.4	12.97			61-66	63	3
do.	do.			14.5		66		1
ICELAND:								
Granastaðir	mid 10th century	10.93-13.72	12.23			53-67	60	9
Tjarnargata 4	9th-10th centuries	13.15-14.33	13.55			64-70	66	4
Adalbol	12th century	12.77-14.23	13.31			62-70	65	3
Hofstaðir	ca. 1000	11.58-13.55	12.49			57-66	61	12
do.				12.55-15.20	13.88	57-69	63	8
Stöng	ca. 1300	12.3-13.7	13.0			60-67	64	4
do.				12.8-15.2	14.0	58-69	64	3
DENMARK:								
Viborg Søndersø	1000-1300	12.59-14.74				62-72	66	19
do.	do.			12.36-15.66		56-71	65	46
Århus Søndervold	10th-12th centuries		13.12				64	10
do.	do.				14.0		64	7
do.	13th-14th centuries		12.61				62	8
do.	do.				13.5		61	8
Næsholm	1240-1340	12.3-13.5	12.8			60-66	63	11
do.	do.			12.5-14.0	13.5	57-64	61	7

Table 16. *Sheep, height at withers. Comparison of material from GUS with contemporaneous samples from Greenland (Western and Eastern Settlements), Iceland, and Denmark. Data from Greenland are from Degerbøl (1936). Bone measurements from the Icelandic sites Granastaðir, Tjarnargata 4 and Adalbol are from North Atlantic Biocultural Organization (2001). Measurements from Hofstaðir were taken by the author (material kept in the Zoological Museum, University of Copenhagen. Degerbøl [1939] published measurements of four metacarpals from Hofstaðir, these were measured anew for consistency but only insignificant differences were found). Data from Iceland (Stöng) are from Degerbøl (1939), those from Viborg Søndersø were provided by T. Hatting (pers. comm.), those from Århus Søndervold are from Møhl (1971), and those from Næsholm from Møhl (1961). Height at withers was estimated from greatest length (GL) of metacarpals and metatarsals using the factors for "ur- und frühgeschichliche Schafe" of Teichert (1975). All measurements are in cm.*

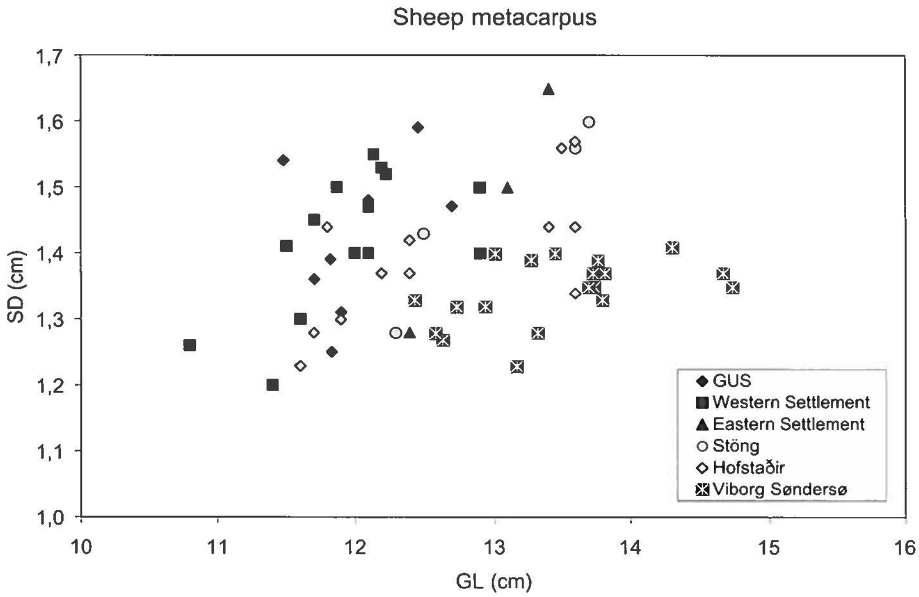


Fig. 27. Sheep metacarpals from GUS and contemporary settlements in Greenland, Iceland and Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the Western and Eastern Settlements are from Degerbøl (1936). Metacarpals from Iceland (Hofstaðir) were measured by the author (cf. Table 16). Data from Iceland (Stöng) are from Degerbøl (1939), and data from Denmark (Viborg Søndersø) were provided by T. Hatting (pers.comm.).

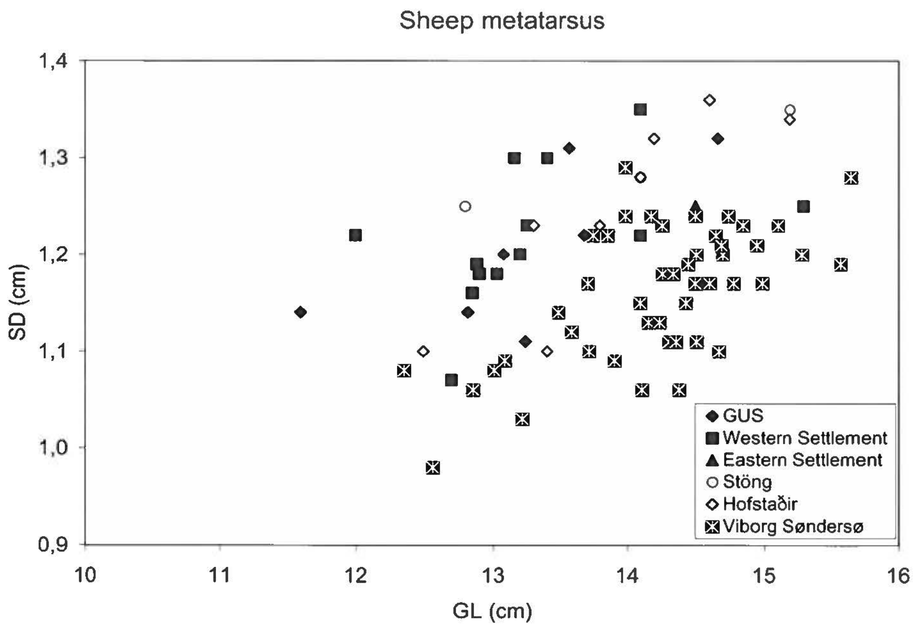


Fig. 28. Sheep metatarsals from GUS and contemporary settlements in Greenland, Iceland and Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the Western and Eastern Settlements are from Degerbøl (1936). Metatarsals from Iceland (Hofstaðir) were measured by the author (cf. Table 16). Data from Iceland (Stöng) are from Degerbøl (1939), and data from Denmark (Viborg Søndersø) were provided by T. Hatting (pers. comm.).

Fig. 29. Metacarpals of sheep from contemporaneous sites in Denmark (the three bones to the left, Viborg Søndersø), Iceland (the three bones in the middle, Hofstaðir), and Greenland (the three bones to the right, GUS). Notice the difference in size and proportions. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

Fig. 30. Metatarsals of sheep from contemporaneous sites in Denmark (the three bones to the left, Viborg Søndersø), Iceland (the two bones in the middle, Hofstaðir), and Greenland (the three bones to the right, GUS). Notice the difference in size and proportions. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

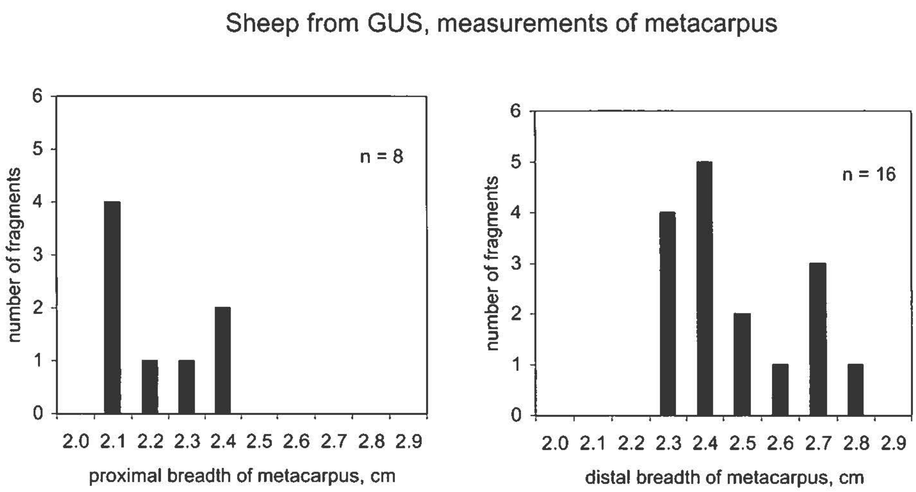


Fig. 31. Frequency distribution of proximal (Bp) and distal (Bd) breadths of metacarpus of sheep from GUS.

tlement indicate that sheep from there were slightly less robust than those from the Western Settlement (and on average larger, cf. above).

Fig. 31 illustrates the frequency distribution of proximal and distal breadths of metacarpus. Altough the material is small, the diagrams show traces of bimodality which might reflect the two sexes, males having stouter metacarpals than females. The range of the distal breadths is similar to that seen in other Norse settlements on Greenland (Degerbøl 1936, McGovern 1992).

Size of goats

A limited number of goat metacarpals and metatarsals could be measured,

GUS sample no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 5.75)
x 83	2.32	–	–	–	–	–
x 2658	2.49	–	1.65	–	–	–
x 2772 dex	2.52	2.70	1.55	–	10.63	61.1
x 2772 sin	2.53	2.68	1.52	–	10.64	61.2
x 3064	–	2.85	–	1.07	–	–
x 3064	–	2.77	–	–	–	–
x 3474	–	2.87	–	–	–	–

Table 17. *Goats from GUS, measurements of metacarpals according to von den Driesch (1976) and estimates of height at withers according to Schramm (see von den Driesch & Boessneck 1974). All measurements are in cm. x 2772 is the complete goat skeleton.*

GUS sample no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 5.34)
x 661	–	2,34	–	–	–	–
x 1097	2.15	–	1.30	1.07	–	–
x 1243	–	2.44	1.25	0.99	–	–
x 1700	2.07	2.60	1.32	1.03	10.82	57.78
x 2943 dex	1.99	2.41	1.36	1.10	11.31	60.40
x 2943 sin	1.99	2.40	1.30	1.09	11.36	60.66
x 3064	1.98	2.39	1.33	1.03	10.68	57.03

Table 18. *Goats from GUS, measurements of metatarsals according to von den Driesch (1976) and estimates of height at withers according to Schramm (see von den Driesch & Boessneck 1974). All measurements are in cm. x 2943 is the complete goat skeleton.*

see Tables 17, 18, and the height at withers using the factors suggested by Schramm (see von den Driesch and Boessneck 1974) was estimated where possible. The few values indicate a height at withers of 57-61 cm.

Figs 32-33 show the breath of goat metacarpals and metatarsals as a function of their length. In addition to specimens from GUS, goats from other sites in the Western Settlement have been included. Degerbøl (1936) from whom

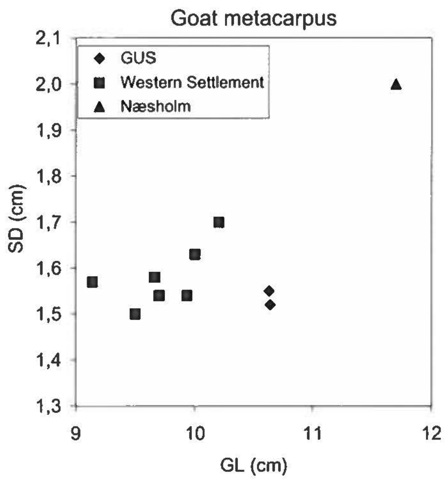


Fig. 32. Goat metacarpals from GUS, from other Western Settlements sites and from contemporary Næsholm in Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the West Settlement are from Degerbøl (1936), those from Næsholm are from Møhl (1961).

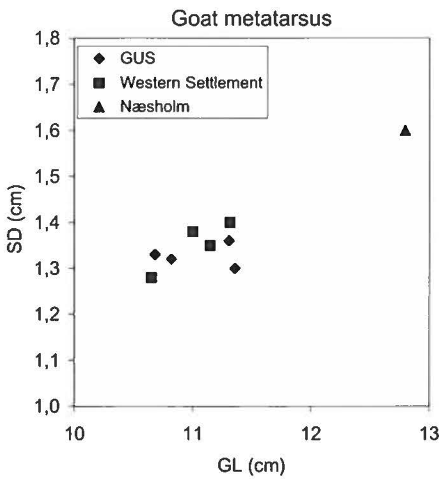


Fig. 33. Goat metatarsals from GUS, from other Western Settlements sites and from contemporary Næsholm in Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the West Settlement are from Degerbøl (1936), those from Næsholm are from Møhl (1961).

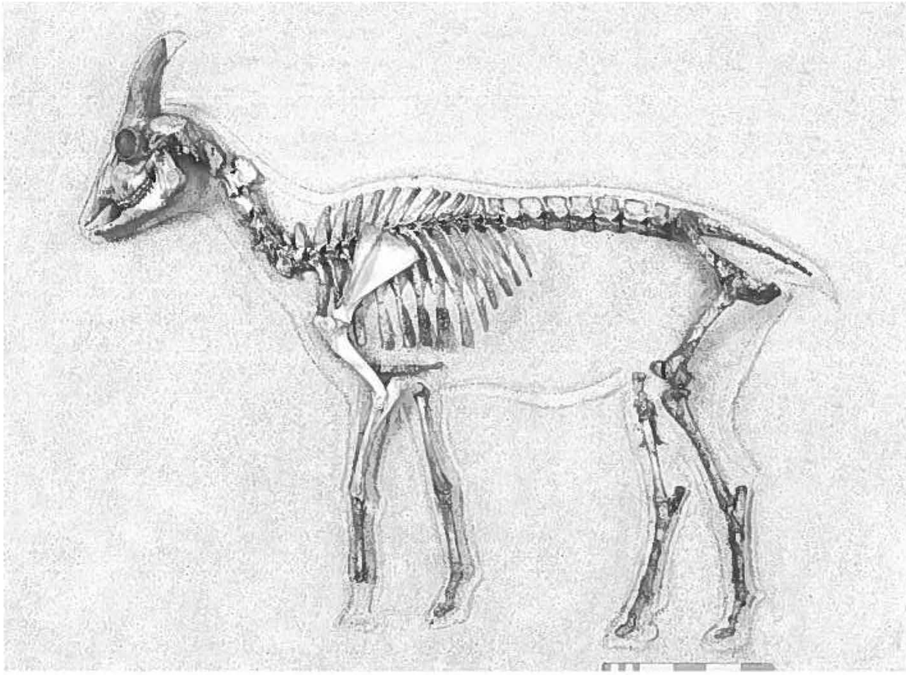


Fig. 34. The complete goat skeleton from GUS arranged in sand. The outline of the animal has been drawn in the sand. Missing parts of the left forelimb are of course not shown, like some skeletal elements of the right side, e.g., the right femur, which are "hidden behind the outline". Scale units 1 and 5 cm. Photo: G. Brovad, Zoological Museum.

Fig. 35. Head of the complete goat skeleton from GUS. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

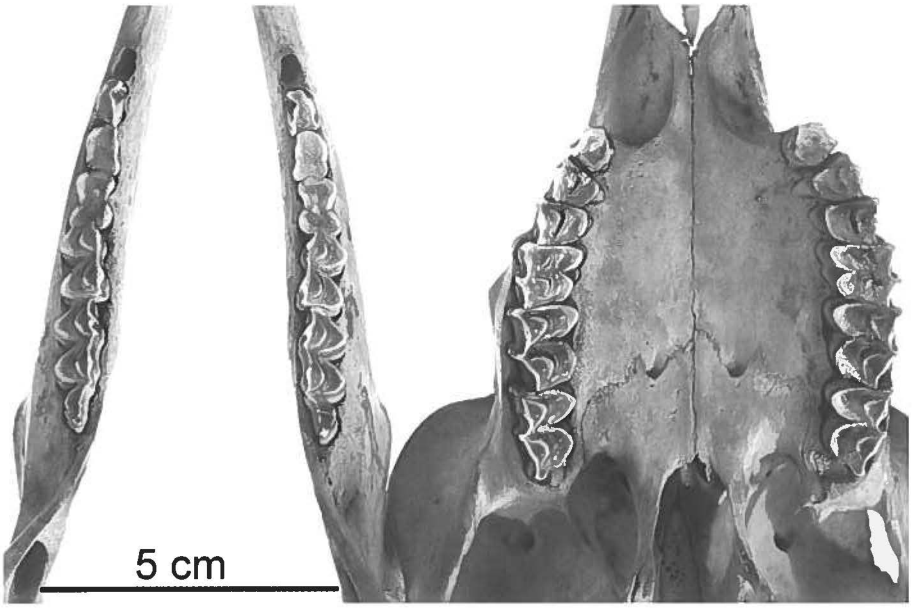


Fig. 36. Lower and upper jaws of the complete goat skeleton from GUS. Scale 5 cm. Photo: G. Brovad, Zoological Museum.

the other Western Settlement measurements have been taken, emphasises that goats from the Western Settlement were small, although some bones are from powerful animals. The measurements of metatarsals of goats from GUS fit well into the general Western Settlement pattern, whereas the two metacarpals from GUS (which are from the complete goat, cf. below) are much more gracile than other goat metacarpals from the Western Settlement. Measurements of a goat from the Danish site Næsholm (AD 1240-1340, *i.e.* contemporaneous with the later part of the settlement period at GUS) are included in Figs 32-33 (data from Møhl 1961), this goat was indeed a lot larger than those from the Western Settlement.

A complete goat skeleton

In addition to the 189 individual bone fragments, a complete goat skeleton was found – one of the most remarkable osteological finds from GUS (Figs 34-36). The skeleton was recovered from under a collapsed house wall. The distal parts of the fore legs were excavated in 1995 (find no. x 2772), and the remaining skeleton in 1996 (find no. x 2943). This is the first find of a complete domestic animal from Norse Greenland and therefore of exceptional interest. The treatment of goat remains from GUS is therefore very much focused on this individual.

Two C-14 datings have been made of the complete goat. One (AAR-4291) indicates 710 ± 45 BP, the other (AAR-4461) indicates 785 ± 30 BP (in conventional ^{14}C years). In other words, the goat is dated to the interval AD 1220-1300. The find of the skeleton inside one of the buildings led to the initial idea that this goat was left behind when the Norsemen abandoned GUS. However, the C-14 datings of the skeleton refer it to an older date (phase 2), as strange as this may seem.

The complete skeleton is extremely well preserved. In many places, hair is still adhering to the bones, and remains of the hoofs and horns are also preserved. With the exception of a few phalanges from the fore legs, a few carpales and a number of sesamoid bones, all skeletal elements are present. A sample of stomach-gut contents has also been recovered but has not yet been analysed.

There is no doubt that the goat is a female. The well-preserved horn cores (Fig. 35) are not at all stout enough for a male, and the morphological characters of the pelvis (Boessneck *et al.* 1964) are also those of a female.

Because of the discrepancy between tooth wear and epiphysal fusion (see below) the possibility that the goat might be a castrated male, was also investigated. However, the horn core was not stout enough even for a castrated male, and the characteristic narrowing of the horn core which develops at the time of castration, was absent. Also the pelvis of a castrated male goat is clearly different from that of a female (the differences correspond to those illustrated for sheep by Hatting 1995).

The skeleton as a whole is quite gracile, with sharp muscular attachment sites similar to those typically seen in wild animals and unlike those most frequently found in domestic ones.

Age estimates of the complete goat skeleton

The age of the complete goat was estimated based on tooth eruption and wear, as well as based on epiphysal fusion.

All teeth of the specimen are preserved, and since all thirds molars (M3) have erupted and show wear, the goat is at least 26 months old (Habermehl 1975). In six years old goats the chewing surface of M1 is smooth-worn (Habermehl 1975). In the present goat, the M_1 chewing surfaces are smooth-worn in the lower jaw, but in the upper M^1, two small crescents are still visible on the chewing surfaces. This would indicate an age of slightly less than 6 years.

The mandibular teeth are heavily worn, especially P_3, P_4, and M_1 (see Fig. 36), perhaps an indication that the food ingested by the goat was contaminated with grit, cf. Tinsley (2001). Using the tooth wear criteria of Grant (1982), both lower jaws show the following pattern: P_4: l, M_1: m, M_2: h, M_3: g. This wear pattern resembles that found in a Recent female Gotland sheep aged 5 years and 9 months.

Table 19 shows the state of epiphysal fusion in the complete goat. The ages for fusion of the various epiphyses were established by Rajtová (see Habermehl 1975). It is evident that many epiphysal sutures are still visible. The goat was therefore not fully grown when it died. Based on the epiphyses that *are* fused, a minimum age of 2 years can be established. Some of the epiphyses that fuse at an age of $2^1/_2$-5 years still show signs of sutures at the edge of the fusion.

Bone	Epiphyses	Age for epiphysal fusion	Condition in the goat skeleton
Humerus	Caput humeri and Tuberc. minus of the the diaphysis	$2^1/_2$ yrs	suture visible
Radius	Distal	5 yrs	epiphysis fused, but suture visible
Ulna	Proximal and distal	$3^1/_2$ yrs	sutures visible
Femur	Proximal	21 mths	no suture
	Distal	$3^1/_2$ yrs	no suture, except for slight indication at one place
Tibia	Proximal	$4^1/_2$ yrs	indistinct suture
	Distal	2 yrs.	no suture
Metatarsus	Distal	3 yrs	no suture
Metacarpus	Distal	3 yrs	no suture

Table 19. *Stages of epiphysal fusion in the complete goat skeleton from GUS. Age criteria after Rajtová (see Habermehl 1975). The vertebrae of the skeleton are in different stages of epiphysal fusion.*

The epiphysal criterion thus gives an age estimate ($2^1/_2$-5 years) somewhat lower than the tooth wear criterion (slightly less than 6 years), which is quite in line with the possible influence of soil in the food mentioned above.

Size estimates of the complete goat skeleton

Calvarium, mandible and limb bones were measured according to the protocol of von den Driesch (1976), see Tables 20-22. Most skeletal elements (metatarsus, humerus, radius, metacarpus) estimate the height at withers to ca. 61 cm. Based on femur, the estimate is ca. 62 cm, whereas tibia gives an estimate of ca. 60 cm. This indicates that the goat had relatively long femora and relatively short tibiae (but still had the total length of the hind legs fitting in with that of the fore legs). See Table 23.

Discussion of sheep/goats

Sheep seem to have played a slightly larger role than goats at GUS (225 vs. 189 identified fragments). The predominance of sheep is most pronounced in phase 3 (60% sheep, Fig. 37) but the difference vis-a-vis phases 1+2 is not significant. GUS does not fit into the general picture outlined by McGovern *et al.* (1996) according to which goats increased in importance through time at the settlements in Vesterbygden.

McGovern *et al.* (1996) calculated the ratio between "meat-rich upper limb bones" (humerus, radius, ulna, femur, tibia) and "relatively meat-poor lower limb bones" (metacarpals, metatarsals, phalanges). He then used the ratio as a basis for estimating whether reindeer, sheep and goat and cattle had been killed far away from the settlement (in which case the meet-rich upper limb bones would be over-represented), or whether they had been slaughtered "at

Measurement		Measurement	
1. Profile length	21.51	23. Length of the premolar row	2.59
2. Condylobasal length	20.85	24. Greatest inner length of the orbit	3.54
3. Basal length	19.04	25. Greatest inner height of the orbit	3.49
4. Short skull length	13.23	26. Greatest mastoid breadth	7.66
5. Premolare-Prosthion	5.74	27. Greatest breadth of the occipital condyles	4.83
7. Viscerocranium length	12.59	28. Greatest breadth at the bases of the paraoccipital processes	7.05
8. Median frontal length	11.13	29. Greatest breadth of the foramen magnum	2.00
9. Akrokranion-Bregma	5.28	30. Height of the foramen magnum	1.80
10. Frontal length	6.97	31. Least breadth of parietal	2.51
11. Upper neurocranium length	10.34	32. Greatest breadth between the lateral borders of the horncore bases	7.21
12. Facial length	14.10	33. Greatest neurocranium breadth	6.70
13. Akrokranion-infraorbitale of one side	14.65	34. Greatest breadth across the orbits	11.52
14. Greatest length of the lacrimal	3.62	35. Least breadth between the orbits	7.71
15. Greatest length of the nasals	6.85	36. Facial breadth	7.15
16. Short lateral facial length	12.00	37. Greatest breadth across the nasals	2.26
17. From the aboral border of one occipital condyle to the infraorbitale	12.75	38. Greatest breadth across the premaxillae	3.15
18. Dental length	11.58	39. Greatest palatal breadth	6.89
19. Oral palatal length	9.77	40. Horncore basal circumference	9.50
20. Lateral length of the premaxilla	8.27	41. Greatest (oro-aboral) diameter of the horncore base	3.43
21. Length of the cheektooth row	5.99	42. Least (latero-medial) diameter of the horncore base	3.50
22. Length of the molar row	4.01	43. Length of the horncore on the front margin	12.4

Table 20. *Measurements of the skull of the whole goat skeleton from GUS. Measurements were taken according to von den Driesch 1976 and refer to the left side of the skull. All measurements are in cm.*

home" at the Sandnes farm. Fig. 19 shows these ratios for the three phases of GUS. With one exception, the ratios from GUS resemble those from Sandnes and indicate, as would be expected, that reindeer was hunted in the wild, whereas sheep, goat and cattle were kept close to the farm. The one exception, sheep and goat in phase 1, might suggest that these species were left to roam in the wild in the early phase of the settlement.

Cattle

Fragments of cattle bones constitute a modest fraction of the GUS material: 659 fragments, or about a third of the number of fragments of sheep and goat.

Measurement	sin	dex
1. Length from the angle	16.18	16.42
2. Length from the condyle	16.93	17.16
3. Length: gonion caudale – aboral border of alveolus of M_3	4.74	4.80
4. Length of horizontal ramus	11.82	12.14
5. Length: gonion caudale – oral border of alveolus of P_2	11.05	11.18
6. Length: gonion caudale – most aboral indentation of the mental foramen	13.04	13.02
7. Length of the cheek tooth row	6.68	6.90
8. Length of molar row	4.53	4.58
9. Length of premolar row	2.18	2.29
10. Length / breadth of M_3	2.24 / 0.84	2.27 / 0.81
11. Length of diastema	4.20	4.04
12. Aboral height of the vertical ramus	6.32	6.27
13. Middle height of the vertical ramus	6.00	6.05
14. Oral height of the vertical ramus: gonion ventrale – coronion	8.60	8.53
15a. Height of mandible behind M_3	3.51	3.47
15b. Height of mandible in front of M_1	2.26	2.05
15c. Height of mandible in front of P_2	1.78	1.76

***Table 21**. Measurements of the mandible of the whole goat skeleton from GUS. Measurements were taken according to von den Driesch 1976. All measurements are in cm.*

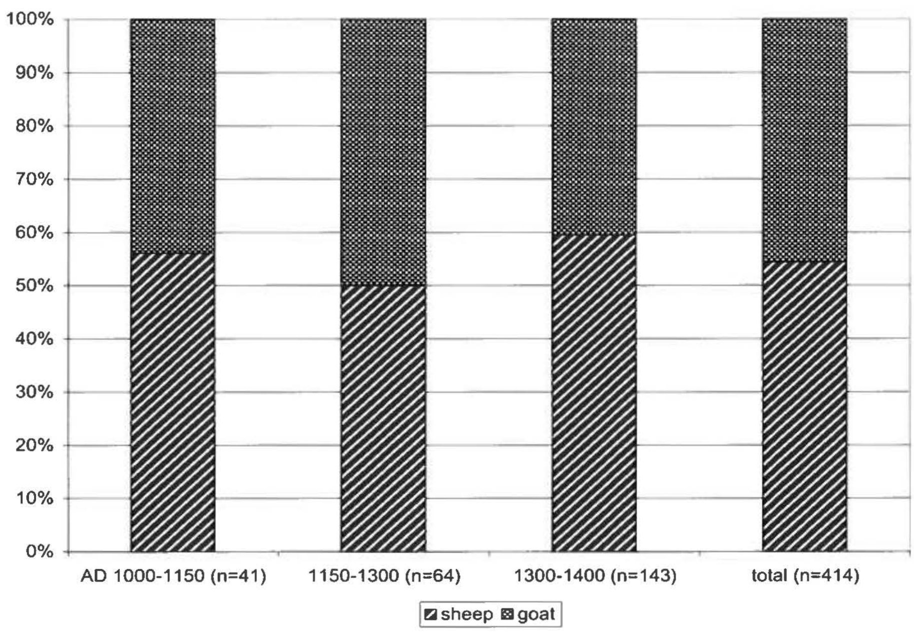


Fig. 37. Relative frequencies of fragments of goat and sheep from GUS in phases 1 (AD 1000-1150), 2 (AD 1150-1300) and 3 (AD 1300-1400), and in the total material.

Bd	= breadth, distal	Dm	= (greatest) depth of medial half
BF_p	= Greatest breadth of Facies articularis proximalis.	DPA	= depth across processus anconaeus
		GB	= greatest breadth
BF_d	= Greatest breadth of Facies articularis distalis	GL	= greatest length
Bp	= breadth, proximal	GLC	= greatest length from caput femoris
BPC	= Greatest breadth across the coronoid process (= greatest breadth of proximal articular surface)	GLl	= greatest length of lateral half
		GLm	= greatest length of medial half
		LO	= length of olecranon
BT	= (greatest) breadth of trochlea	SD	= Smallest breadth of diaphysis
DD	= (smallest) depth of diaphysis	SDO	= smallest depth of olecranon

Humerus		BT	SD			GL
		3.20 / 3.17	1.64 / 1.64			15.72 /15.77
Radius + Ulna						GL
						19.30 / 19.15
Radius	Bp	Bd	SD	BFp	BFd	GL
	3.04 / 3.07	2.98 / 2.92	1.72 / 1.80	2.87 / 2.87	2.53 / 2.50	15.24 / 15.17
Ulna	LO	BPC	SDO	DPA		GL
	3.48 / 3.42	2.40 / 2.44	2.30 / 2.26	2.58 / 2.53		18.97 / 19.09
Femur	Bp	Bd	SD	GLC		GL
	4.20 / 4.05	3.86 / 3.75	1.48 / 1.45	17.38 / 17.25		18.05 / 18.01
Tibia	Bp	Bd	SD			GL
	4.22 / 4.29	2.71 / 2.70	1.45 / 1.44			20.14 / 20.15
Metatarsus	Bp	Bd	SD	DD		GL
	1.99 / 1.99	2.41 / 2.40	1.36 / 1.30	1.10 / 1.09		11.38 / 11.26
Astragalus	Dm	Bd	Dl	GLm		GLl
	1.63 / 1.63	1.85 / 1.82	1.48 /1.49	2.66 / 2.68		2.84 / 2.88
Calcaneus				GB		GL
				2.17 / 2.10		5.71 / 5.69
Metacarpus	Bp	Bd	SD			GL
	2.53/ 2.52	2.68 / 2.70	1.52 / 1.55			10.64 / 10.63

Tabel 22. *Measurements of limb bones of the whole goat skeleton from GUS. Measurements were taken according to von den Driesch (1976). Entries are measurements in cm from the left (before stroke) and right (after stroke) sides.*

The relative importance of cattle, (measured as the percentage of identified fragments) seems to decrease over time, from 15% in phase 1 to 6% in phase 3, see Fig. 12. The proportion of meat-rich versus meat-poor bones shows that cattle was kept at the farmsite (Fig. 19, cf. also above under sheep/goat).

Age structure of cattle from GUS

Age of cattle was estimated on the basis of molar teeth (M_1-M_3) *in situ* in the

Measurement	value	estimated height at withers
Femur GL left	18.05	62.27
Femur GL right	18.01	62.13
Tibia GL left	20.14	59.82
Tibia GL right	20.15	59.84
Metatarsus GL left	11.38	60.77
Metatarsus GL right	11.26	60.13
Humerus GL left	15.72	60.68
Humerus GL right	15.77	60.87
Radius GL left	15.24	60.66
Radius GL right	15.17	60.38
Metacarpus GL left	10.64	61.18
Metacarpus GL right	10.63	61.12

Table 23. *Estimates of the height at withers of the whole goat from GUS. Measurements were taken according to the standards of Schramm (see von den Driesch & Boessneck 1974). All measurements are in cm. GL = greatest length.*

jaws, see Fig. 38. The number of recovered jaws that could be scored for tooth wear was quite low. Therefore, age estimates were also made on individual, mandibular dp_4 and M_3, see Fig. 39, which contains information from loose (not shed) dp_4 and M_3 as well as those still *in situ* in the mandibles. The evidence from the three diagrams is thus in part overlapping. Mandible wear stages and tooth wear stages were classified according to Grant (1982), and stages were translated to age classes according to Legge (1992). Interpretation of tooth wear patterns is subject to considerable uncertainty. For instance, Mainland (2001) showed that tooth wear in Norse sheep from Greenland was affected by soil/grit in the food. *Mutatis mutandis*, the age estimates for cattle may therefore be somewhat too high.

In spite of this complicating factor, and in spite of the moderate numerical basis, it appears that most cattle were slaughtered either very early (during

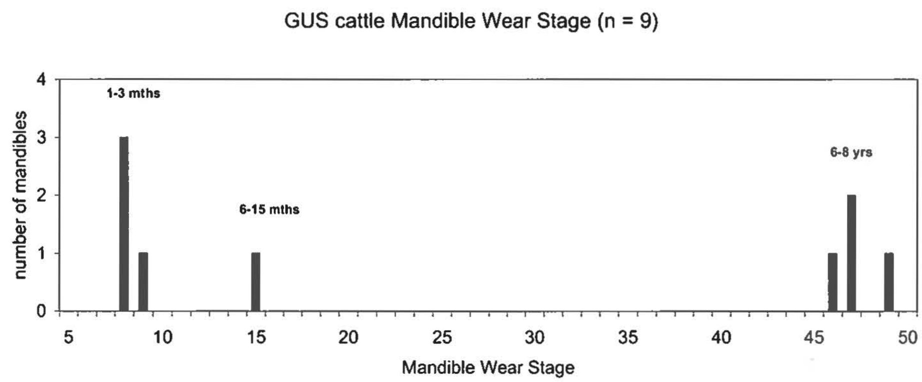


Fig. 38. Age distribution of cattle from GUS based on mandible wear stages sensu Grant (1982).

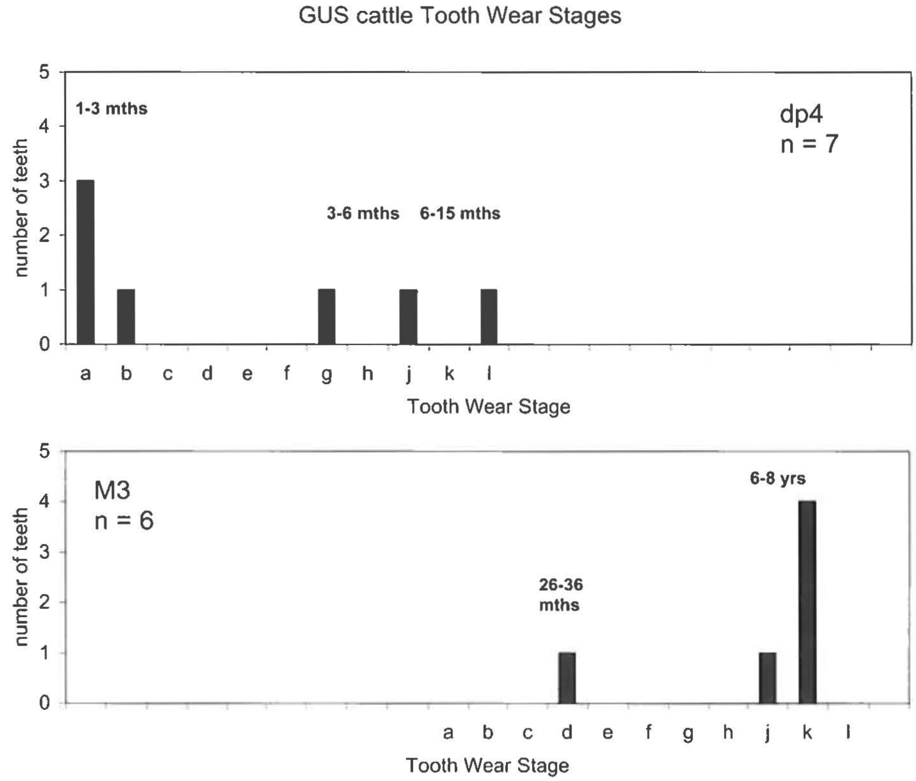


Fig. 39. Age estimates for cattle from GUS based on wear patterns sensu Grant (1982) for individual, mandibular dp_4 and M_3.

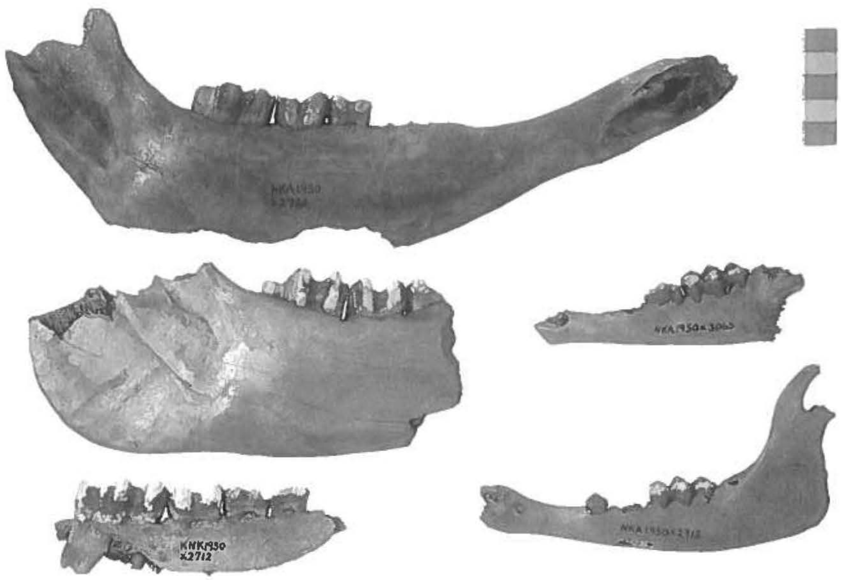


Fig. 40. Typical examples of mandibles of cattle excavated at GUS. The three mandibles to the left are from cattle aged 6-8 years, and the two mandibles to the right are from calves 1-3 months old. Notice fractures indicating marrow extraction in two of the mandibles from adult cattle. Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

GUS sample no.	Phase no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 6.15)
x 270	–	5.43	–	2.70	2.03	–	–
x 678	3	5.44	5.67	3.11	2.18	17.15	105.5
x 1819	2 & 3	4.50	5.12	2.61		16.65	102.4
x 1819	2 & 3	–	4.68	–	–	–	–
x 2944	1	5.58	–	–	–	–	–
x 3092	1	5.26	5.21	2.74	2.03	18.24	112.2
x 3301	1	4.77	–	–	–	–	–

Table 24. *Cattle from GUS, measurements of metacarpals according to von den Driesch (1976) and estimates of height at withers according to von den Driesch & Boessneck (1974). All measurements are in cm.*

the first year) or at a considerable age (6-8 years), cf. Fig. 40. This suggests that milk rather than meat was the most important cattle product. If meat had been the primary product, most cattle would have been slaughtered at the age where rapid growth is beginning to slow down (about 2 years according to Legge [1992]), or shortly thereafter.

A focus on milk production can be understood in terms of efficiency. It is well known that in modern practice the use of cattle for milk gives three to four times the yield per hectare, as does the raising of animals for meat (Legge 1992). In a situation like the one, which must have prevailed at GUS, the provision of fodder of cattle must have been a difficult task, and it is natural that an optimisation of the yield must have been a high priority.

Cattle size

Measurements were taken of metapodials (metacarpals and metatarsals) for estimates of size and proportions (robustness) of the GUS cattle. Tables 24, 25 show the results. Due to the high degree of fragmentation of the GUS bone material, the number of measurable metapodials was quite low. The breadth of metapodials, particularly metacarpus, can often be used to separate the sexes (cows and bulls) in cattle. Bulls have broader metacarpals, and a frequency distribution will therefore be bimodal. If the above interpretation of cattle husbandry at GUS as primarily aimed at milk production is correct, one would expecte a much smaller number of bulls than cows. Unfortunately, the small material did not allow the detection of bimodality, let alone the relative height of two peaks.

Based on the greatest length of metapodials, the height at withers was estimated using the factor of von den Driesch and Boessneck (1974). Because sexes could not be separated, the mean of the factors for the two sexes was

GUS sample no.	Phase no.	Breadth, proximal (Bp)	Breadth, distal (Bd)	Smallest breadth of diaphysis (SD)	Smallest depth of diaphysis (DD)	Greatest length (GL)	Height at withers (GL x 5.45)
x 874	–	4.59	Ca. 5.71	2.57	2.57	20.25	110.4
x 892	–	4.95	5.73	2.67	2.44	19.40	105.7
x 1097	4	3.85	4.39	1.89	1.98	19.15	104.4
x 1487	3	4.58	–	2.44	2.38	–	–
x 2160	–	4.31	–	2.12	2.34	–	–
x 2713	–	4.43	–	–	–	–	–
x 2744	–	4.00	4.57	2.20	2.20	19.73	107.5
x 2856	3	–	–	2.46	2.30	–	–
x 2856	3	4.40	4.69	2.48	2.38	20.83	113.5
x 2944	1	4.33	–	–	–	–	–
x 2944	1	–	–	–	2.16	–	–
x 3448	–	4.40	4.90	2.28	2.30	19.47	106.1

Table 25. *Cattle from GUS, measurements of metatarsals according to von den Driesch (1976) and estimates of height at withers according to von den Driesch & Boessneck (1974). All measurements are in cm.*

used. Estimates from metacarpal and metatarsal measurements range from 102-112 cm and 104-114 cm, respectively.

The height at withers of the GUS cattle varies from 102 to 114 cm, with an average of 106 cm (metatarsus) or 108 cm (metatarsus). The small material did not allow a comparison of cattle sizes between the time phases.

The cattle from GUS fit well into the general size pattern of cattle from the Western and Eastern Settlements. This cattle was small in comparison with contemporaneous cattle from Iceland and Denmark (Table 26) as also pointed out by Degerbøl (1936) who noticed that the Norse Greenlandic cattle is smaller than Danish Medieval cattle, even though the Medieval cattle was small compared to modern cattle.

In the scatter diagrams, Figs 41-42, greatest length and smallest diameter of cattle metapodials from GUS are illustrated together with corresponding measurements from other Norse sites in Greenland (Western and Eastern Settlement) and from contemporaneous sites in Iceland and Denmark. No measurements of metacarpus were available from the Eastern Settlement, nor from Iceland. These diagrams illustrate size and proportions of the bone at the same time.

Greatest length (GL) is a measurement of size (height at withers). The symbols representing GUS material tends to be situated in the left portion of the diagrams, although some of the individuals from other Norse Greenlandic sites are smaller.

Robustness of the metapodials, and hence, by inference, of the cattle, is il-

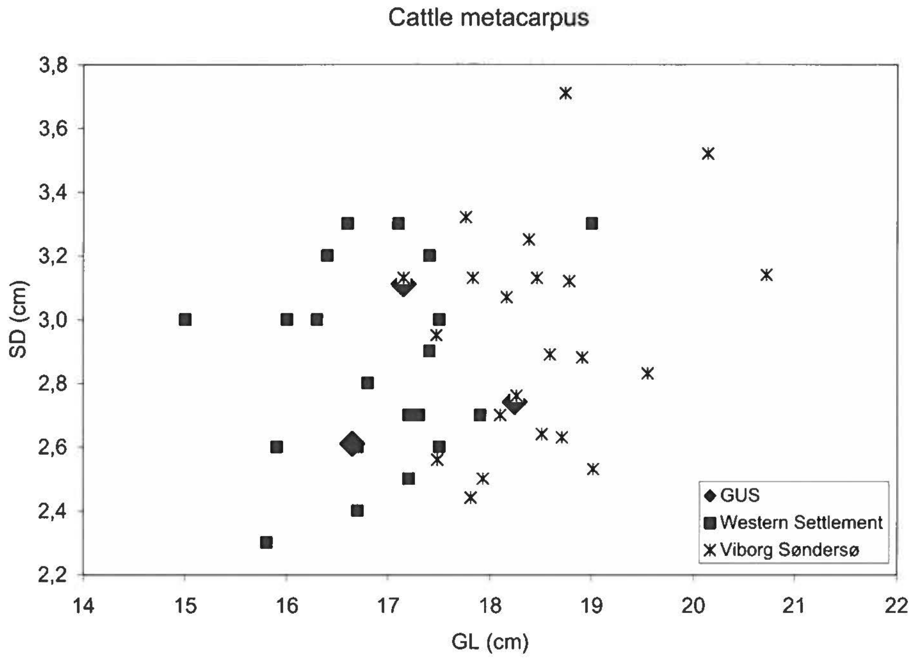


Fig. 41. Cattle metacarpals from GUS and contemporary settlements in Greenland (Western Settlement) and Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the Western Settlement are from Degerbøl (1936), and data from Denmark (Viborg Søndersø) were provided by T. Hatting (pers. comm.).

lustrated by the ratio between smallest diameter (SD) and greatest length. Robust metapodials occupy positions in the upper left part of the diagram. The symbols representing GUS cattle are quite scattered throughout the point swarm, in accordance with Degerbøl (1936) who noticed the variability in cattle from the Western Settlement and ascribed this to a "mixed stock" of cattle. Part of the variability may, however, also be due to sexual differences.

Horse

Sixty-two bones of horse from GUS does not look like a very high number, but in comparison with other Norse sites on Greenland, it is actually a lot, cf. Degerbøl (1936) and McGovern (1985). Thus, the bone material from the chieftain's farm Sandnes included only two horse bones. From GUS, there are horse bones from phases 1, 2 and 3. They represent the entire skeleton (cf. Tables 5-7): head, vertebrae, ribs, shoulder girdle, legs and feet. One find (no. x 1890) represents remains of the distal parts of a left hind leg (astragalus, calcaneus, tarsale 2, tarsale 3, tarsale 4+5, centrale, metatarsale 2, metatarsale 3, metatarsale 4). There are cutmarks on metatarsale 3, indicating that this horse was skinned.

Locality	dating, AD	meta-carpus GL, range	meta-carpus GL, average	meta-tarsus GL, range	meta-tarsus GL, average	height at withers, range	height at withers, average	n
GREENLAND:								
GUS	ca. 1000-1400	16.65-18.24	17.35			102-112	106	3
do.	do.			19.15-20.83	19.81	104-114	108	6
Western Settlement	ca. 1000-1360	15.0-19.0	16.9			92-117	104	22
do.	do.			18.0-20.6	19.2	98-112	105	14
Eastern Settlement	ca. 1000-1450			19.0-20.7	20.0	104-113	109	7
ICELAND:								
Stöng	1300			20.0-21.6	20.9	109-118	114	5
Hofstaðir	1300			20.0-21.2	20.5	109-116	112	5
DENMARK:								
Viborg Søndersø	1000-1300	17.15-20.72	18.47			105-127	114	22
do.	do.			19.58-22.62	20.89	107-123	114	14
Århus Søndervold	10th-12th centuries		17.6				108	10
do.	do.				19.69		107	
do.	13th-14th centuries		17.89				110	10
do.	do.				20.62		112	
Næsholm	1240-1340	16.5-20.6	18.1			101-127	111	50
do.	do.			18.4-22.6	20.6	100-123	112	36

Table 26. *Cattle, height at withers. Comparison of material from GUS with contemporaneous samples from Greenland (Western and Eastern Settlements), Iceland, and Denmark. Data from Greenland are from Degerbøl (1936), and those from Iceland from Degerbøl (1939). Bone measurements from Viborg Søndersø were provided by T. Hatting (pers.comm.), those from Århus Søndervold are from Møhl (1971), and those from Næsholm from Møhl (1961). Height at withers was estimated from greatest length (GL) of metacarpals and metatarsals using the mean factors for male and female from von den Driesch & Boessneck 1974. All measurements are in cm.*

Age estimates

Eight fragments of jaws (mandibula, premaxillary and maxillary) could be used for age estimation, see Table 27. Age was estimated by means of state of tooth eruption (Habermehl 1975) and tooth wear (comparison with Recent skeletons of known age, kept in the Zoological Museum, University of

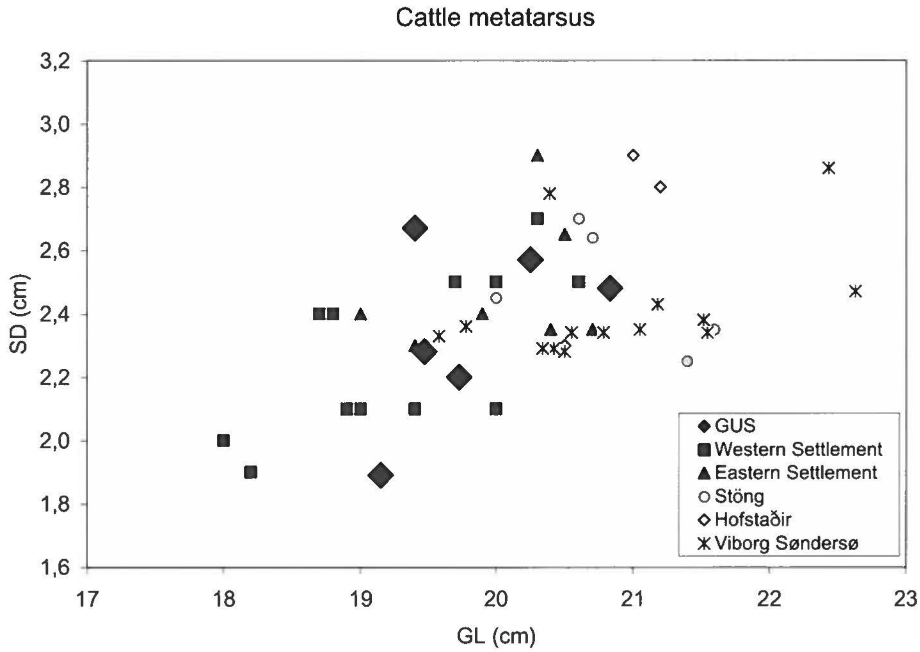


Fig. 42. Cattle metatarsals from GUS and contemporary settlements in Greenland (Western and Eastern Settlements), Iceland and Denmark. Greatest length (GL) and smallest diameter (SD) of bones. Data from the Western and Eastern Settlements are from Degerbøl (1936), data from Iceland (Stöng and Hofstaðir) from Degerbøl (1939), and data from Denmark (Viborg Søndersø) were provided by T. Hatting (pers. comm.).

GUS sample no.	Age according to Habermehl (1975)	Age estimated by comparing to recent material	Criterion	n
x 575	> 4 years	10-15 years*	M_3 erupted	
			heavy tooth wear	1
x 575	ca. 2 years*		M_2 about to erupt	1
x 825	> 4 years	at least 15 years*	M_3 erupted	
			heavy tooth wear	1
x 935		c. 15 years	heavy tooth wear on M^1 and M^2	1
x 1029	> 4 years	c. 6 years	M^3 erupted	
			tooth wear like 6 years old	1
x 1343	7-11 months		I^3 erupting	1
x 1432	7-11 months		I^3 erupting	1
x 2034	12-19 months		wear on dp_2 and dp_3	1

Table 27. *Age estimates for horses from GUS. Age was estimated on the basis of tooth eruption and wear in fragments of mandibula, premaxillary and maxillary bones. Estimates marked with an asterisk were taken from Nyegaard (1992).*

Copenhagen). Based on tooth eruption, the bone fragments can be referred to foals of 7-11 months' age and horses 12-19 months old, ca. 2 years old, and older than 4 years. The latter group (older than 4 years) was estimated by means of tooth wear to consist of horse aged 6 to at least 15 years. Also for horses the possibility should be considered that a high content of soil/grit in the ingested food may have accelerated tooth wear, and may hence lead to exaggerated age estimates (cf. Mainland 2001).

Size estimates

The metatarsus (metatarsale 3) mentioned above was measured and compared with a contemporaneous horse from Iceland and a modern Icelandic horse (Table 28, Fig. 43). Nyegaard (1991) provided a measurement of a further horse metatarsus from GUS.

Degerbøl (1936) found that the few fragments of horse by then known from Norse settlements in Greenland were from horses similar to modern Icelandic horses. This small, stout breed has a average height at withers of 133 cm. The new finds of horse from GUS do not change this impression.

A few measurements were taken of tibiae, these are also similar to those of the modern Icelandic horse measured by Møhl (1961).

Measurements of a tibia and a mandible by Nyegaard (1992) are also similar to measurements of modern Icelandic horses.

Discussion of horses

As remarked by Degerbøl (1936) it is no surprise that the Norse horses from Greenland are similar to Icelandic ones, considering that the colonists probably came from Iceland. What is a surprise, though, is the relatively high

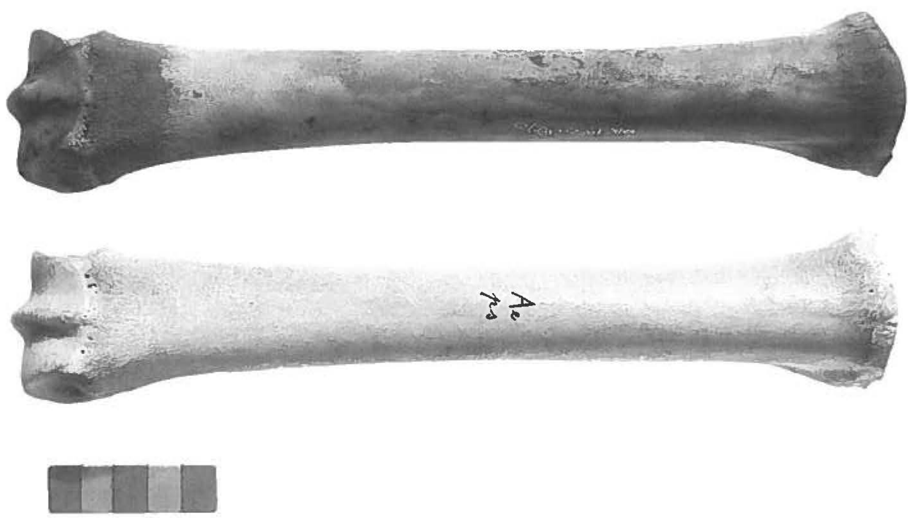


Fig. 43. Metatarsale III of a horse excavated at GUS (left) compared with the same skeletal element of a Recent Icelandic horse (right). Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

	Greatest length (GL)	Greatest length of lateral part (GL1)	Lateral length of outer side (L1)	Greatest breadth of proximal end (Bp)	Smallest breadth of diaphysis (SD)	Smallest circumference of diaphysis (CD)	Greatest breadth of distal end (Bd)
GUS x 1890	25.12	25.00	24.45	4.74	2.64	8.10	4.42
GUS x 16	–	–	–	–	–	–	4.60
East Settlement	26.0	–	–	–	2.8	–	–
Hofstaðir, Iceland	26.9	–	–	–	3.0	–	–
Iceland, recent	24.5	–	–	–	3.0	–	4.7

Table 28. *Horses from GUS, measurements of metatarsus compared with more or less contemporaneous horses from the Eastern Settlement (Degerbøl 1939), Hofstaðir, Iceland (Degerbøl 1939) and a modern Icelandic horse (Møhl 1961), measurements according to von den Driesch (1976). All measurements are in cm.*

number of horse bone fragments at GUS. Considering the general rarity of horse remains on Greenlandic Norse sites, one would expect the horse to have been a high status animal. In contrast, a mere two horse bone fragments have been recovered from Sandnes, which has been interpreted as a chieftain's farm (McGovern *et al.* 1996).

Swine

Only a single remain of swine was found – a scapula fragment. This bone could have been brought in sitting in a pork shoulder, and thus does not prove swine husbandry at GUS. The swine seems in general to have played a minor role in the Norse households in Greenland. In particular there are few remains of swine in the Western Settlement (McGovern 1985). However, Degerbøl (1936) recorded a few swine bones from the Western Settlement and because two skull fragments were included, interpreted them as indication of swine husbandry.

Dogs

Thirty-six bones of dogs were recovered from GUS, some of which could be referred to phases 2 and 3 (Tables 2, 6, 7).

A complete dog head

A well-preserved dog skull with both associated mandibles and the first two vertebrae (find no. x 1638, phase 3, Fig. 44) is of exceptional interest among the dog bones from GUS. Measurements of the skull and the associated left mandible are given in Tables 29, 30. The sutures on the brain case are still visible. This would suggest a young dog, but nevertheless the teeth are very worn, especially P^4 and M^1. A possible explanation for this would be that the

Fig. 44. Skull and left mandible from the complete dog head excavated at GUS. Scale 5 cm. Photo: G. Brovad, Zoological Museum.

dog had been castrated. Crista sagittalis is weakly developed. The skull as a whole is of a long type and the long maxilla houses a weak set of teeth with large diastemata between premolars as well as between canines and incisors. The upper profile line is sloping evenly, and there is no proper "frontal stop", only a faint depression in the middle.

These characteristics suggest that the dog has been of the greyhound type. The skull is relatively broad across the front, and there is no domed part in front of the eyes. This domed part was found in the Viking Age Errindlev dog from Denmark (Brinkmann 1921, Degerbøl 1943) and is regarded as typical of Russian greyhound types. The profile of the dog from GUS rather reminds of the Sandnæs dog (Degerbøl 1936) in which the frontal slope is normal, like in English greyhound types (Degerbøl 1943). However, the GUS skull (total length 21.4 cm) is considerably more oblong than the Sandnæs one (total length 19.8 cm). This difference is also reflected in the much larger tooth diastemata in the GUS dog. (The total length of the Errindlev dog is 22.3 cm, Brinkmann 1921). Møhl (1961) found several greyhound type dogs (skull length 20.4-22.1 cm) at the Danish medieval site Næsholm and compared them with a recent English greyhound (skull length 21.9 cm). See Fig. 45.

Brinkmann (1921: 41-42) recommended his so-called "frontal index" (Stirnlageindex) which expresses the relation between the length of the cerebral and facial parts of the skull (calvarium) for characterising dog races.

The index is calculated as 100 x the distance between the frontal midpoint and the I^1 alveolus (= "facial length" of von den Driesch 1976), divided by the distance between the posterior margin of the foramen magnum and the frontal midpoint. Von den Driesch (1976) did not include the latter measurement in her protocol.

The higher the frontal index, the relatively longer the snout. The frontal index for the GUS dog is 100 x 12.74 (cf. Table 29) divided by 9.7 = 131. This val-

Measurement			Measurement		
1.	Total length	21.44	21.	Length / breadth of M^2	sin: 0.62/0.91 dex: 0.61/0.96
2.	Condylobasal length	19.56	22.	Greatest diameter of auditory bulla	2.95
3.	Basal length	18.70	23.	Greatest mastoid breadth	7.14
4.	Basicranial axis	9.00	24.	Breadth dorsal to external auditory meatus	6.96
5.	Basifacial axis	13.95	25.	Greatest breadth of occipital condyles	3.94
7.	Upper neurocranium length	9.86	26.	Greatest breadth of bases of the foramen magnum	5.67
8.	Viscerocranium-lenght	11.33	27.	Greatest breadth of foramen magnum	2.16
9.	Facial length	12.74	28.	Height of foramen magnum	1.63
10.	Greatest length of nasals	8.30	29.	Greatest neurocranium breadth	6.42
11.	Length of braincase	–	30.	Zygomatic breadth	–
12.	"Snout" length	12.80	31.	Least breadth of skull	4.32
13.	Median palatal length	10.80	32.	Frontal breadth	6.05
13a.	Palatal length	10.28	33.	Least breadth between orbits	4.22
14.	Length of the horizontal part of the palatine	3.90	34.	Greatest palatal breadth	6.48
14a.	Length of the horizontal part of the palatine corresponding to M 13a	3.36	35.	Least palatal breadth	3.46
15.	Length of cheektooth row	6.92	36.	Breadth of canine alveolus	ca. 3.70
16.	Length of the molar row	1.68	37.	Greatest inner height of orbit	–
17.	Length of the premolar row	5.45	38.	Skull height	6.29
18.	Length of the carnassial	sin: 1.77 dex: 1.77	39.	Skull height without sagittal crest	5.88
18a.	Greatest breadth of carnassials	sin: 0.81 dex :0.82	40.	Height of occipital triangle	4.44
20.	Length / breadth of M1	sin: 1.22 / 1.33 dex: 1.20 / 1.32	41.	Height of canine	4.13

Table 29. *Measurements of the dog skull (x 1638) from GUS. Measurements were taken according to von den Driesch 1976 and refer to the left side of the skull except where otherwise indicated. All measurements are in cm.*

ue falls within the range for English greyhounds: 129-137 according to Brinkmann (1921). In contrast, the index for the Sandnæs dog, which according to Hatting (1982) was almost certainly a hunting dog, is only 120 (Degerbøl 1936), but the Danish Errindlev dog has an index as high as 140.4 (Brinkmann 1921), thus falling within the range for Russian "Barzoi" greyhounds.

	x 1638 sin	x 2960 dex	x 3065 dex	x 16 dex
1. Total length: from condyle process – infradentale	15.92	c. 15.41	–	15.79
2. Length from angular process – infradentale	15.62	15.07	–	15.67
3. Length from indentation between condyle process and angular process – infradentale	14.91	14.43	–	14.95
4. Length from condyle process – aboral border of canine alveolus	14.04	13.77	–	14.00
5. Length from indentation between condyle process and angular process – aboral border of canine alveolus	13.24	12.88	–	13.26
6. Length from angular process – aboral border of canine alveolus	ca. 13.80	13.45	–	13.90
7. Length from aboral border of alveolus of M_3 – aboral border of canine alveolus	9.0	8.85	–	9.14
8. Length of cheektooth row, $M_3 – P_1$	8.06	8.15	–	8.29
9. Length of cheektooth row, $M_3 – P_2$	7.48	7.55	–	7.69
10. Length of molar row	3.60	3.68	–	3.66
11. Length of premolar row, $P_1 – P_4$	4.53	4.41	–	4.65
12. Length of premolar row, $P_2 – P_4$	3.90	3.76	4.37	4.08
13. Length / breadth of carnassial	1.98 / 0.84	1.99 /	–	2.16 / 0.88
14. Length of carnassial alveolus	2.07	1.97	2.45	2.19
15. Length / breadth of M_2	0.84 / 0.60	0.88 / 0.62	–	0.97 / 0.71
16. Length / breadth of M_3	0.46 / 0.42	–	–	–
17. Greatest thickness of body of jaw	1.20	1.02	1.41	1.22
18. Height of vertical ramus	5.60	5.48	–	5.96
19. Height of mandible behind M_1	2.51	2.40	3.08	2.76
20. Height of mandible between P_2 and P_3	2.02	1.80	2.33	1.93
21. Height of canine	–	4.25	–	–

Table 30. *Measurements of dog mandibles from GUS. Measurements were taken according to von den Driesch 1976. All measurements are in cm. No teeth were present in mandibula x 3065; P_1 and P_4 must have been missing for a considerable time before the dog's death since the alveoli are closed; some of the measurements taken may therefore be "unnatural" since the remaining teeth may have compensated for the gaps in the tooth row.*

Fig. 45. Skull of the complete dog head from GUS (middle) compared with a contemporaneous skull from a greyhound-type dog from the castle Næsholm, Denmark (left) and a skull of a Recent English greyhound (right). Scale units 1 cm. Photo: G. Brovad, Zoological Museum.

Not surprisingly, the mandibles belonging to the skull have features coresponding to those of the skull. The long snout of the dog is also here revealed by larged diastemata between the teeth. The coronoid processes have a curved posterior margin (for a discussion of this character, see Crockford 2000).

Recently, von Mosczinsky (2001, 2002) developed a method for distinguishing skulls and mandibles of greyhounds from other type of dogs. She found that only one simple measurement (von den Driesch's measurement M35: least palatal breadth measured behind the canines) was statistically different between greyhound and other dogs, but in spite of the statistical significance, there was considerable overlap and the measurement alone is therefore not diagnostic. Instead, von Mosczinsky developed discriminant functions, one for the skull and one for the mandibles.

The discriminant function for skulls is: 1.031086 + (0.057441 x M17) + (0.049487 x M27) – (0.016460 x M35) – (0.030331 x M36).

See Table 29 for explanation of measurements. The threshold value for greyhound is 1.5361756 (when the measurements are in mm), and to qualify as a greyhound, the value should approach 2.

The value of the discriminant function for the GUS dog is: 1.031086 + (0.057441 x 54.5) – (0.049487 x 21.6) – 0.016460 x 34.6) – 0.030331 x 37) = 1.40.

The discriminant function for mandibles is 0.064610 + (0.045047 x M11) + (0,290220 x M15 [length]) – (0,367024 x M16 [breadth]) –(0,089258 x M20).

See Table 30 for explanation of measurements. The threshold value for greyhound is 1,61543312 (when the measurements are in mm), and to qualify as a greyhound, the value should approach 2.

The value of the discriminant function for the GUS dog is: 0.064610 + (0.045047 x 45.3) + (0.290220 x 8.4) – 0.367024 x 4.2) – 0.089258 x 20.2) = 1.20.

Both index values are below the threshold values for greyhounds but are still much higher than found for the vast majority of non-greyhound-types by von Mosczinsky (2001).

This dog can therefore not be classified as a typical greyhound based on von Mosczinsky's method, but may still be regarded as a greyhound-like type.

Other dog bones

None of the other dog mandibles from GUS (Table 30) are complete enough for calculation of von Mosczinsky's discriminant indices. One of them (find no. x 2906, unknown phase) is similar to the one discussed above, being long, slender and with large tooth diastemata (the coronoid process is broken). In contrast, the mandible from find no. x 3065 (unknown phase, coronoid process broken off) is very heavily built and stems from a very old dog: all teeth are missing, and alveoli for P_1 and P_4 are also absent (proving that these teeth had been lost a long time before the dog's death). It is impossible to see whether the teeth have been removed purposely or have simply been lost due to high age. North of the farm (find no. x 16, phase unknown) two fragments of a dog head were found. One fragment is the left side of the calvarium of a relatively young dog (several sutures not fused), the other is an entire mandible with the teeth from the canine, C, back to and including M_2 present. The degree of tooth wear indicates that the mandible cannot derive from the same dog as the calvarium fragment. The mandible is similar to that belonging to the complete dog head (x 1638) with regard to length, and has the same curved shape of the coronoid process, but it is much more heavily built. Measurements of this mandible correspond to measurments of three more or less contemporaneous (Viking Age and Medieval) Danish dogs from Trelleborg, Næstved and Lille Lyngby (Nyegaard 1991)

A number of fragments of limb bones are also present. These include a large, well-preserved scapula from a very old dog. This bone exhibits a healed fracture and many traces of dog gnawing. In size and appearance it reminds very much of the scapula of the Errindlev dog (see above), although it is slightly longer and stouter (Table 31). Most probably this scapula comes from a dog of the same, greyhound-like type that is indicated by the complete head and one of the loose mandibles.

The other limb bones in the material are all too fragmented for measuring, but a simple comparison with other subfossil and recent dog skeletons leaves one with an impression of a mixture of large, medium-sized and small dog types at GUS (see also Nyegaard 1992).

Measurement	GUS x 1033	Errindlev Fælled
Height along spine (HS)	17.69	16.11
Diagonal height from most distal point of scapulae to thoracic angle (DHA)	17.15	15.81
Smallest length of Collum scapulae (SLC)	3.11	3.14
Greatest length of Processus articularis (GLP)	4.17	3.92
Length of glenoid cavity (LG)	3.53	3.47
Breadth of glenoid cavity – greatest breadth of glenoid angle (BG)	2.51	-

Tabel 31. *Measurements of the dog scapula x 1033 from GUS compared with the Viking Age dog from Errindlev Fælled (Brinkmann 1921). Measurements according to von den Driesch (1976). All measurements are in cm.*

Discussion of dogs

The dog bones from GUS indicate that the dogs kept at the site belonged to several different types, as also noticed for other Norse sites in Greenland by Degerbøl (1936) and Hatting (1982).

Berglund (1997) described two illustrations of dogs from artifacts found at GUS: a figure carved and etched into the end piece of a small box or chest, and a carved figure. The former picture "suggests a stout dog with broad chest, strong shoulders, wide snout and a marked transition between the snout and the skull" (Berglund 1997). The picture certainly not represents a greyhound-type, but rather a Mastiff-type dog (Berglund 1997).

The head of the latter figure is also very stout, and although similarity with a dog is moderate, Berglund (1997) has no better guess.

At least some of the dogs from GUS were probably used as hunting dogs. Fragments of heavily built dogs (e.g., the mandible from find no. x 16) might derive from guard dogs, whereas the greyhound-like dogs may have served as status symbols.

The complete dog head shows traces of a violent blow to the left side of the braincase (parietal), an indication that the Norsemen sometimes treated their dogs quite roughly.

House mouse

Quite a number of bones of house mouse were found many of which are from phase 3. In addition to 63 registered mouse bones fragments, mostly from sieved samples, samples have been collected which contain numerous bones of juvenile house mice together with remains of their fur. The latter samples were taken close to a fireplace in the weave room, phase 3 (G. Nyegaard pers. comm.), which probably was a nice warm place for the mice to live. The

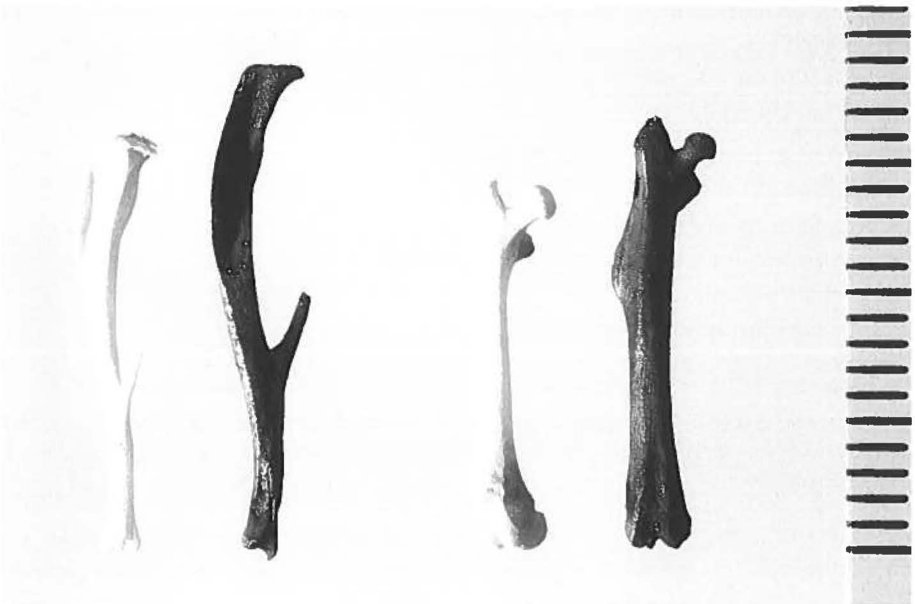


Fig. 46. Hind leg bones of a juvenile house mouse excavated at GUS (dark bones) compared to corresponding bones from an adult male house mouse from Denmark (pale bones). Left: tibiae, right: femora. The difference in length would have been even more pronounced if the house mouse from GUS had been an adult, since the proximal epiphysis is missing from the juvenile GUS tibia, and the distal epiphysis is missing from the juvenile GUS femur. Furthermore, the diaphysis (shaft) might have grown longer before attainment of adulthood. Scale units 1 mm. Photo: G. Brovad, Zoological Museum.

house mouse had obviously been introduced to Greenland by the Norsemen. It can survive in heated houses but cannot overwinter in the open (Vibe 1990).

A preliminary comparison with Recent Danish house mice leaves the impression that mouse femora and tibiae are unusually long (Fig. 46). In this connection it is worth noticing that house mice on the Faroe Islands are distinguished by their quite large size, with particularly well developed hind legs (Reinert 1971). Degerbøl (1940) wrote: "It will be evident from the description that on a number of North Atlantic islands, several forms of mammals: *Mus, Apodemus, Microtus* show a parallel development resulting in a greater size than found in the corresponding mainland forms..." (*Apodemus* is a genus of mice, *Microtus* a genus of voles).

Certainly, the Norse house mice deserve a closer study. The species is known from several Norse sites, sometimes represented by numerous bone fragments, e.g. Vatnahverfi (McGovern 1992).

The roles of animals at GUS

Overview

The farm GUS was situated in a favourable environment near the inner branches of the Ameralla Fjord (Fig. 1) and surrounded by vegetation allowing some animal husbandry.

The most important domestic animals were sheep and goats, the former slightly dominating in numbers. Sheep and goat complement each other in terms of exploitation of food resources, goats being better at eating bushes. The reconstructed survivorship curve for sheep and goats suggests that they were kept mainly for their meat, but there is archaeological evidence that their wool and hairs were used by the GUS people. Sheep and goats from GUS are generally small and stout, probably well adapted to the extreme conditions of climate and terrain. One goat, represented by an entire skeleton, is, however, more gracile than the norm.

Cattle was kept, too, but at a more modest scale, about one third as many cattle as sheep/goats. The main function of the cattle seems to have been milk production. The cattle were small in comparison with contemporaneous Danish cattle, but of quite variable stoutness.

The bone material does not document pig breeding.

Besides the domestic animals, the inhabitants at GUS had a large and reliable food resource at their disposal, the seals. The harp seal was by far the commonest, followed by common seal. The seals could in part be caught at a short distance from GUS (common seal), in part at sealing expeditions to the outer parts of the fjord system or even to the ocean coast (mainly harp seal).

Reindeer also played a significant role, especially during the first phases of the settlement. Reindeer could be caught inland, and the absence of juvenile individuals, as well as the relationships between remains of meat-rich and meat-poor parts of the body show that the reindeer from GUS were wild animals which were hunted, and not tame ones which were kept. This observation agrees with the reports on reindeer drive systems from Western Settlement sites by McGovern and Jordan (1982) and McGovern (1985).

The Arctic hare seems to have constituted a minor but constant contribution to the menu and has also provided fur and hair. The low percentage of hare bones (1-2% of the identified bones) is certainly in part due to the general excavation technique and the role of this small species for the GUS people has certainly been significant.

The remaining mammals of which remains have been found at GUS, viz., house mouse, dog, Arctic fox, polar bear, walrus, horse and whales, have – entirely or in part – served other functions. The skeletal elements of walrus represented show that meat-rich parts of this species were brought to GUS.

However, the walrus was especially hunted because its tusks were much coveted as a trading object. Polar bear was hunted with a view for trade as well, and the Arctic fox was presumably killed for its fur. Whales are hard to interpret, and we have no idea of how much whale meat might have been brought in at the farm. What is obvious is that whalebones were used for various purposes. The dogs from GUS were quite diverse and were probably used for hunting and watching (sheep dogs?) as well as mere status symbols. The mice had certainly not been brought to Greenland on purpose. They served their own ends and thrived in the warm parts of the buildings, enjoying the absence of cats.

Among the birds killed by the GUS people, the ptarmigan seems to have been a constant element in the meals, whereas other bird species have played smaller and more occasional roles. Ptarmigan and some other species, such as geese, would have been killed in the inland, sea birds, e.g. auks, play only a small role. Some bird species, such as white-tailed eagle, were hardly eaten. The eagle probably played a special role at GUS, since only remains of wings have been found. Wings of geese and maybe raven might have served similar purposes.

Fishing is well documented at GUS, much better so than at other Norse sites in Greenland although the number of recovered fish bones is not overwhelmingly large. The moderate numbers may in part be due to the excavation technique employed, but maybe also to conditions of preservation. The majority of fish bones are from salmonid fishes, especially Arctic char, however with a supplement of other species such as cod and halibut which themselves hunted Arctic char in the river mouths. The small species, capelin and stickleback, may have been eaten by the GUS people, but their remains may also derive from stomach contents of larger fish or seals. (In this connection it is worth noticing that seals, which are great consumers of capelin, seem to have been gutted before they were transported to GUS.)

Summarising, the picture of GUS provided by the animal bones is one of a farm at which the activities were very much concentrated in the neighbouring inland areas: animal husbandry, reindeer hunting, hares, ptarmigan, a few geese, fishing for char. In addition there is a very important contribution of seals, which in part could have been taken close by (common seal), but in part would require trips to the coastal areas (harp, bearded and hooded seals). Walrus and polar bear would occasionally have visited the coastal of the Nuuk area, but large-scale exploitation would have required expeditions to the more northerly Disko Bay area. It is uncertain whether whales have been hunted actively by the inhabitants, or whether the bones are from stranded whales.

The annual cycle

McGovern (1985: fig. 7) presented a hypothetical seasonal cycle of activities in Norse Greenland. The findings at GUS agree with McGovern's scheme. Cod fishing in the threshold fjord Ameralla during summer may be added as a new element in the seasonal cycle.

Development through time

The subdivision of the excavated material into chronological phases offers an almost unique opportunity to follow the temporal development of the exploitation of animals at a Norse farm in Greenland.

Already during the oldest phase of the settlement (phase 1), seals in large quantities were eaten by the GUS people. Seals thus answer for 28% of the identified mammal bones from phase 1. Through the following phases, seals gain in importance: 36% in phase 2 and 41% in phase 3, see Fig. 12. Taking the entire settlement period as a total, the harp seal was the most important seal species, but in the earlier phases (1 and 2), common seal was more heavily exploited than harp seal, in contrast to the later phase 3, which is strongly dominated by harp seal (Fig. 15). One might speculate that the Norsemen initially killed so many common seals at the nearby breeding sites that the seal population decreased? Bearded seal constituted a constant, minor contribution, remaining seal species are only occasional.

Reindeer were important, being only surpassed in terms of bone fragments numbers by seals and sheep/goat. Their influence as judged by the number of bone fragments was by far largest in phase 1 (27%), dropping off to 13% in phase 2 and 12% in phase 3. This decrease might be ascribed to the well-known natural population fluctuations.

Sheep and goats were of very large importance at GUS as providers of meat, milk and wool/hairs. There is a tendency for an increase in the numerical importance of sheep/goat through time (Fig. 12) from 27% in phase 1 to 33-35% in phases 2 and 3. Sheep have been slightly more numerous than goats, the sheep dominance being most obvious in phase 3 (Fig. 37).

The large number of goats already in phase 1 is remarkable, since goats were not very common in contemporaneous Iceland (McGovern 1992) or Denmark (Hatting 1998). Perhaps the GUS inhabitants had learnt from experience at other Norse sites in Greenland that having many goats was a good idea?

The role of cattle seems to have decreased through time, from 15% of identified mammal bones in phase 1, to 11% in phase 2 and a mere 6% in phase 3 (Fig. 12). In comparison with sheep/goat there are a little more than half as many cattle bones in phase 1, less than a third as many in phase two, and less than a fifth as many in phase 3.

The remaining species of animals, like birds and fishes, do not show obvious changes over time.

Summarising, there are several indications of temporal changes in the economy of GUS: The exploitation of seals increases, that of reindeer decreases, sheep and goat become slightly more numerous, and cattle becomes scarcer.

When interpreting the development in time, it should be borne in mind that phase 1 covers the first 150 years of settlement, phase 2 the next 150 years, and phase 3 the last 100 years. (Phase 4 covers the period after the settlement had been abandoned and is not taken into consideration.) It is thus not possible, on the basis of the subdivision into phases, to pinpoint conditions at the very beginning or the very end of the settlement period. This is a pity, because it would have been interesting to know the GUS people's "starter set" of domestic animals, as well as the possibly extreme situation just before the settlement was abandoned. A relatively small number of bones could be referred to building phases I+II (1000-1100) and VIII (1350-1400), respectively (cf. introduction) but a study of the distribution on species of these bones did not add anything to the coarser patterns revealed by the three main phases (1, 2 and 3).

Wild versus domestic, and marine versus terrestrial animal food

The ratio between wild and domestic mammals, as evidenced by the bones, remains approximately 1:1 throughout the period of occupation. The proportion of wild animals is quite large, considering that the settlers were vikings coming from an agricultural society.

Separating the mammals that may have served as food into marine species (seals, walrus, whales) and terrestrial ones (Arctic hare, swine, reindeer, sheep, goat, cattle) reveals an increase i the exploitation of marine mammal resources over time. In phase 1, 29% of the mammal bone fragments are from marine species, in phase 2 the marine percentage has risen to 39%, and in phase 3 it reaches 44% (Fig. 47). Birds and fishes have not been included in the calculation of marine/terrestrial ratios. Including them would not have changed the pattern of development through time because no temporal trends of the exploitation of birds and fish are evident. The birds from GUS were predomiantly terrestrial (mostly ptarmigan), and the fishes include both definitely marine species (e.g., cod, halibut) and the Arctic char which might have been caught both in the marine and fresh waters. The constant presence of shells of edible marine bivalves (mussels, scallops) in the sediment samples from GUS suggests that these molluscs were also part of the diet.

Whales are jokers in any discussion of marine/terrestrial ratios. It is impossible to get an impression of the importance of these large animals as a source of food for the GUS people.

Nevertheless, it may be concluded that the importance of marine food resources increased through time at GUS.

Lynnerup (1998) and Arneborg *et al.* (1999) studied the stable carbon isotope composition ($\delta^{13}C$) of the bone collagen of Greenlandic Norsemen buried in the churchyard of Sandnes. They found that the food of the Norsemen underwent a change from the beginning to the end of the settlement. Whereas

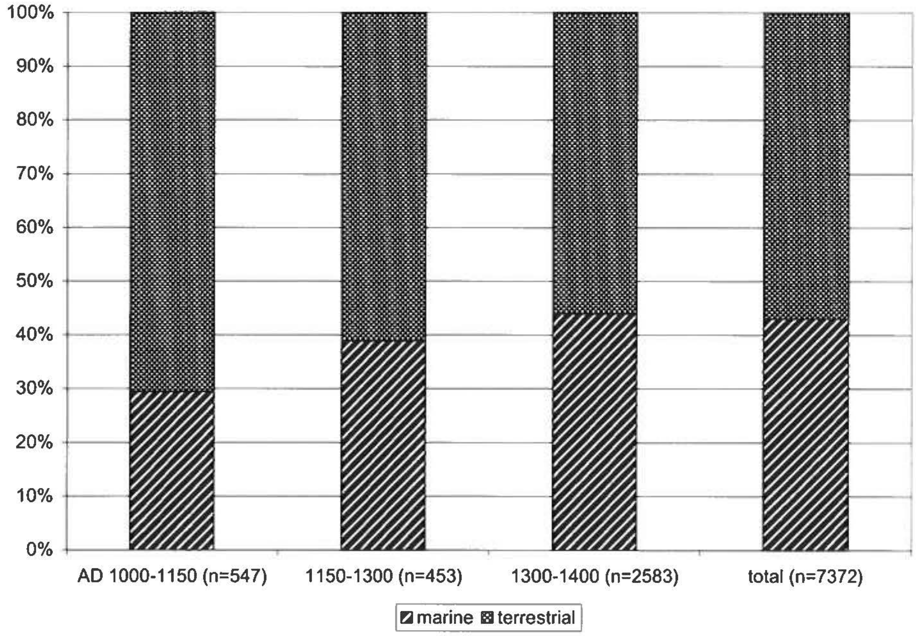


Fig. 47. Relative frequencies of fragments of marine (seals, walrus, whales) and terrestrial (Arctic hare, swine, reindeer, sheep, goat, cattle) mammals from GUS in phases 1 (AD 1000-1150), 2 (1150-1300), 3 (1300-1400) and in the total material.

the food was mostly of terrestrial origin in the beginning, in the end it was predominantly marine. Lynnerup (1998) found a change from 25% to 60%, Arneborg *et al.* a change from 20% to 80% of marine food.

Even though the animal bone material suggests an increasing exploitation of marine animals at GUS, there is no indication of such a dramatic shift as suggested by the $\delta^{13}C$ studies.

It should be borne in mind, though, that the churchyard of Sandnes may have functioned as the burying place for people from several different settlements in the area. For instance, inhabitants from Niaquusat, where a very large proportion (82%) of the mammal bone material consists of seal bones, may also have been buried at Sandnes. If by chance the human skeletons from the late phases of the Western Settlement studied by Lynnerup (1998) and Arneborg *et al.* (1999) are from inhabitants of Niaquusat, this would explain the indication of predominantly marine food.

GUS in a broader perspective

GUS and Nipaatsoq – two neighbour farms

Nipaatsoq was like GUS a farm in the Western Settlement (Møhl 1982; Buckland *et al.* 1983; McGovern 1985). It was situated just across the river from GUS, at most a couple of kilometres away. McGovern (1985) noticed that the animal bone material from Nipaatsoq is from the later part of that settlement, therefore a comparison with phase 3 of GUS is particularly relevant. Indeed the relative abundance of mammal species is remarkably similar between Nipaatsoq and GUS phase 3 (cf. Figs 12, 48) although there are slightly more reindeer from Nipaatsoq.

The bone assemblages from GUS and Nipaatsoq differ from those recovered at other Norse farms in the area, see below.

The similarity between the two collections of mammal bones might be taken as an indication that they are both representative of the composition of mammals. It should, however, be borne in mind that at both sites, the bones were recovered from inside the ancient buildings. Inclusion of midden material might have provided further insight.

Most of the bird bones from Nipaatsoq are from ptarmigan. Also in this respect Nipaatsoq and GUS agree, whereas on most other Norse settlement, auk bones dominate (McGovern *et al.* 1993).

No more than 11 fish bones were found at Nipaatsoq, representing Arctic char and halibut.

Like at GUS, the marine element among the animals at Nipaatsoq is not sufficiently large to explain the highly "marine" $\delta^{13}C$ values of late Norsemen.

Comparison with Sandnes – an elite Norse manor farm

Sandnes was a chieftain's farm in the Western Settlement. Sandnes had a church and probably served as the center for a number of farms in the area. It was situated at the head of the Ameralla Fjord about 15 km in direct line NNW of GUS and Nipaatsoq. The excavated material is referable to four time phases (AD 1025-1150, 1150-1200, 1200-1250 and 1250-1325).

McGovern *et al.* (1996) studied animal remains from Sandnes and found a somewhat different pattern of animal exploitation than that seen at GUS and Nipaatsoq (Fig. 49). The difference is mostly due to a large proportion of walrus bones (17% of the fragments in the early phase, 28-35% in the later ones). Among all Norse sites in Greenland, Sandnes is the one with the highest numbers and proportion of walrus bones. But the proportion of seal bones vis-a-vis domestic mammals (sheep, goat and cattle) is much higher than at GUS and Nipaatsoq, and there is more cattle relative to sheep and goats. In contrast to GUS, reindeer gains in numerical importance through

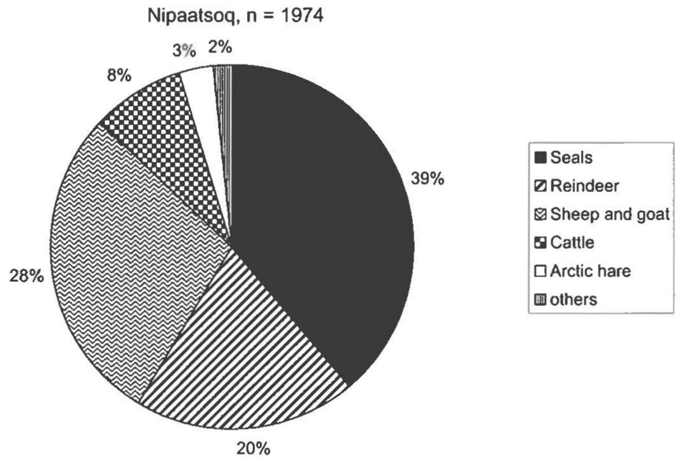


Fig. 48. Mammal bones from Nipaatsoq. Relative frequencies of mammal species/species groups for the total material, based on numbers of identified fragments (McGovern 1985).

time at Sandnes (this might be interpreted as a counter-argument against ascribing the relative decrease of reindeer at GUS to natural population fluctuations). The marine element is more predominant at Sandnes than at GUS, even if walrus (which may not have been eaten to any large extent) is excluded from the calculation. The relationship between domestic and wild species at Sandnes is not straightforward: wild species are relatively more abundant in the earliest and latest phases whereas domestic species are better represented in the middle phases.

Comparison with Niaquusat

Fig. 50 shows the composition of the mammal bone assemblage from Niaquusat, a site situated about 10 km W of Sandnes, on the northern bank of the Ameralla Fjord. The bones were studied by McGovern (1985). The animal bone assemblage from Niaquusat is dramatically different from those from GUS, Nipaatsoq, and Sandnes. Marine dominance is extreme: 82% of the mammal bones are from seals. The stratigraphy at Niaquusat is unfortunately not as simple as initially suggested and the suggested division into phases may not hold (Arneborg 1991). It is therefore not possible to follow the development of seal exploitation through time, and Fig. 50 summarises the entire Niaquusat mammal bone assemblage.

GUS in the framework of the Western Settlement

The analysis of animal bone assemblage from GUS adds to our understanding of conditions in the Norse Western Settlement in Greenland. By and large, the animal pattern fits into the general Western Settlement pattern vis-

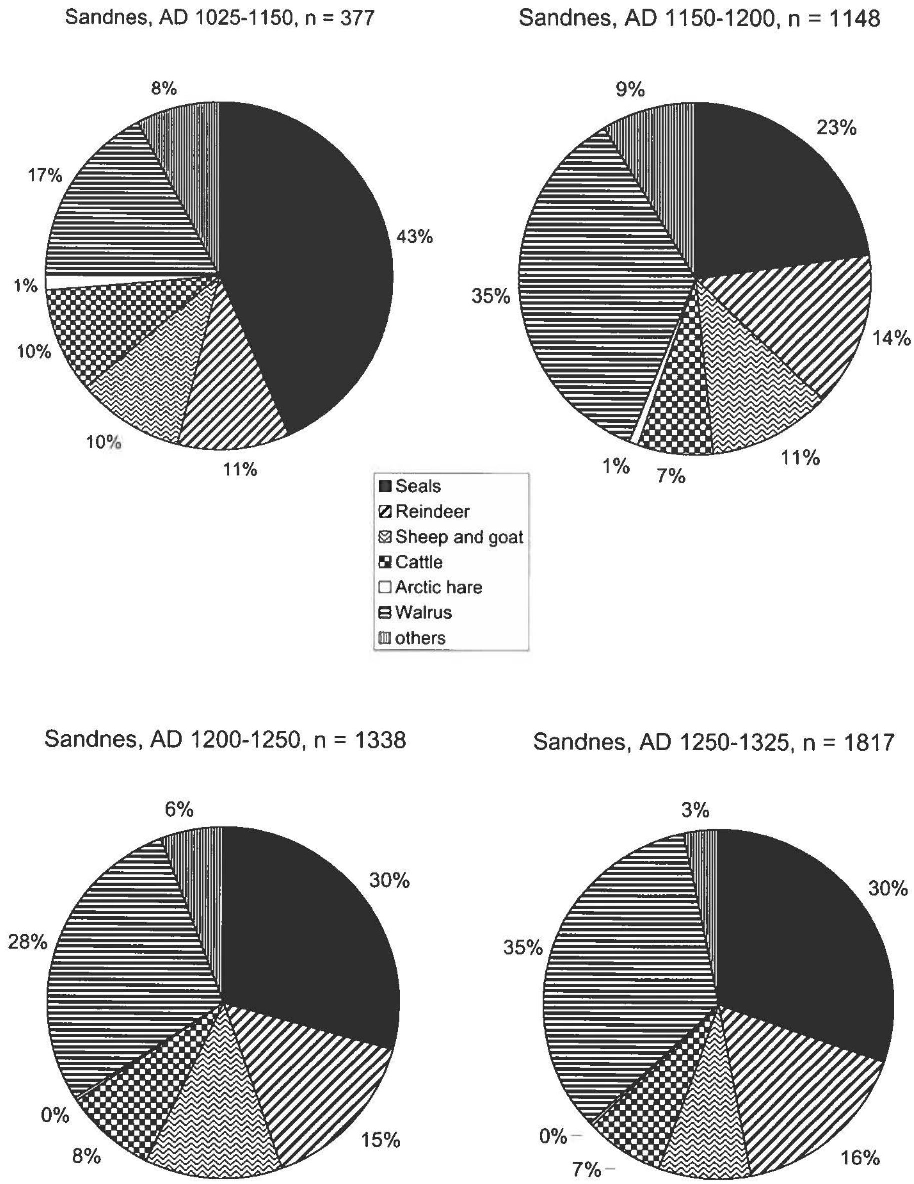
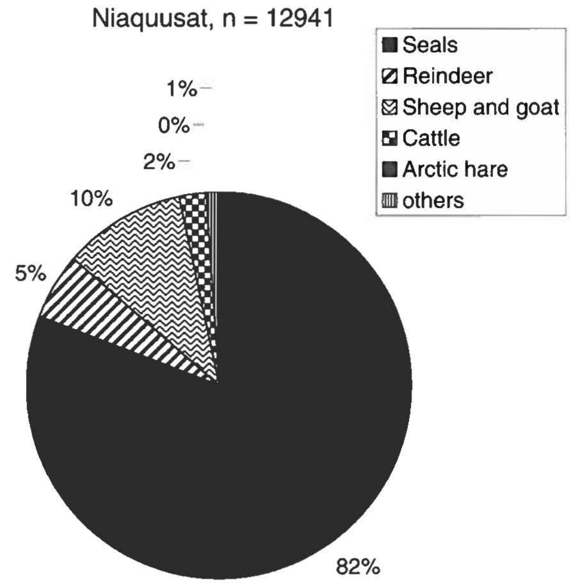


Fig. 49. Mammal bones from Sandnes. Relative frequencies of mammal species/species groups for four phases of occupation, based on numbers of identified fragments (McGovern et al. 1996).

a-vis that of the Eastern Settlement. The following traits are shared between GUS and most other Western Settlement sites, but not those in the Eastern Settlement:

- The harp seal is the most abundant seal, followed by common seal, with a moderate but constant sprinkling of bearded seal, and with single hooded and ringed seals (cf. Degerbøl 1936; McGovern 1985).

Fig. 50. Mammal bones from Niaquusat. Relative frequencies of mammal species/species groups for the total material, based on numbers of identified fragments (McGovern 1985).



- Walrus is represented not only by bones associated with the tusks but also with meat-bearing bones, indicating that its meat was utilised.
- Reindeer is relatively wellrepresented. (Reindeer was important in both the West and the Eastern Settlements, but played a greater role in the subsistence in the former (McGovern 1985)).
- The animal husbandry was strongly dominated by sheep/goat. Cattle are not so prominent, and swine is rare.
- The size of sheep and cattle lies within the range of variation known from the Western Settlement; sheep and cattle from the Eastern Settlement were slightly larger.

GUS, like its neighbour Nipaatsoq, is regarded as a medium-status farm and as one of the farms that was "centered upon the churchfarm ... Sandnes" (McGovern 1985). The main impression from the animal bone assemblage agrees with this notion. There are, however, some aspects of the GUS material, which indicate a certain status:

There are relatively many bones of horses at GUS, deriving from several individual horses. Considering how few horse bones have been found at all Norse sites in Greenland, the horse has probably not been a common animal and not accessible to everybody. (As a caveat, it should be borne in mind that a dead horse might have been disposed of differently from meat-producing domestic mammals.)

There is also a number of dog bones, more than is normal for the Western Settlement farms. Actually, the numbers of dog bones from GUS and the high-status farm Sandnes are identical. (The same caveat as for horse bones applies to dog bones!). Even more interesting than sheer numbers is the fact that some of the GUS dog bones (skull, mandible, scapula) seem to derive from greyhound-type dogs. A greyhound is typically regarded as a status symbol – an object of luxury – and some dog limb bones from Sandnes may also belong to greyhound (Degerbøl 1936). The greyhounds were probably imported from Europe. For instance, several dog bones from the Danish castle Næsholm (AD 1240-1340) are from English greyhounds (Degerbøl 1943; Møhl 1961).

Concluding remarks

The people inhabiting GUS managed an animal husbandry at this northern site, and they did so throughout a period of climatic deterioration.

Sheep and goats were numerous, and there were almost as many goats as sheep, a situation unknown in either Denmark or Iceland where there are few goats. There are fewer cattle, and as time went by, the proportion of cattle dwindled. Pig breeding had been given up, or was at most of such a minimal extent that no traces are left in the bone material.

There were domestic animals at GUS throughout the settlement period, even during the last, difficult phase. Based on sheer numbers of bone fragments, domestic and wild mammals were equally important for the GUS people throughout the period of occupation. This observation agrees with the findings of Schweger (1998), who found no signs of non-sustainable farming in the area around GUS. On the contrary, the area seems to have become more productive as time went on. Sheep, goats and cattle were low and of a robust stature, probably in adaption to the harsh climate and terrain.

The GUS people did, however, also depend on the wild fauna, especially seals and reindeer, but also on birds and fish. Wild animals were exploited from the beginning of the settlement period and until the end. Seals seem to have been of increasing importance through time, while reindeer decreased. Unlike other Norse sites in Greenland, GUS has produced a considerable number of fish bones, which underscore the importance of fishing at GUS. Nevertheless, the Norsemen's dependence on the wild fauna never approached the degree seen in Inuit societies. In the last phase, the economy of GUS was heavily based on seal hunting and on sheep and goat husbandry.

Acknowledgements

This faunal analysis was supported by TUPOLAR (The Danish Research Council's special programme in support of Arctic research), NOS-H (Joint Committee of the Nordic Research Councils for the Humanities) and SILA – The Greenland Research Centre at the National Museum of Denmark. The Zoological Museum, University of Copenhagen, provided workspace and reference collection. The AMS 14C Dating Laboratory in Århus provided datings.

Jette Arneborg, the National Museum, co-ordinator of the GUS project, placed the GUS animal bones at my disposal, provided all kinds of information and was a constant support throughout the period of analysis and writing.

Kim Aaris-Sørensen of the Zoological Museum suggested my participation in the project. Gitte Gotfredsen identified part of the bird bones. Carl C. Kinze identified the whale bones. Gotfred Høpner Petersen identified bivalve shells. Tove Hatting let me use her unpublished bone measurements from Viborg Søndersø. Knud Rosenlund was always helpful and encouraging in numerous ways. Jeppe Møhl helped with arranging the complete goat skeleton. Gert Brovad did the photographic work.

Tom McGovern, City University, New York, provided bone measurements from the NABO Zooarchaeological Archive.

Lars Heilmann, Greenland Institute of Natural Resources, Nuuk, provided information on the occurrence of cod in the Ameralik fjord system. Georg Nyegaard, Qaqortoq Museum, gave information on mouse bones.

Hans Kapel, the National Museum, provided unpublished information on a fishing hook.

Henrik Enghoff was a stimulating discussion partner, constructed the diagrams and translated the manuscript to English.

I extend my sincere thanks to all these institutions and persons.

References

Albrethsen, S.E. and Òlafsson, G. 1998. A Viking Age hall. – In: Arneborg, J. and Gulløv H. C. (eds.) Man, Culture and Environment in Ancient Greenland. Danish National Museum and Danish Polar Center pp. 19-30.

Amorosi, T., McGovern, T. H. and Perdikaris, S. 1994. Bioarchaeology and cod fisheries: a new source of evidence. – ICES marine Science Symposia 198: 31-48.

Andreasen, C. 1980. Nordbosager fra Vesterbygden på Grønland. – Hikuin 6: 135-147.

Andreasen, C. 1982. Nipaitsoq og Vesterbygden. – Tidsskriftet Grønland 5-7: 177-189.

Andreasen, C. and Arneborg, J. 1992. Gården under Sandet. Nye nordboarkæologiske undersøgelser i Vesterbygden. – Grønlandsk Kultur- og Samfudsforskning 92: 11-50.

Arneborg, J. 1985. Nordboarkæologiske undersøgelser ved Kilaarsarfik i Nordboernes Vesterbygd. – Tusaat 2/85: 2-9.

Arneborg, J. 1991. The Niaquusat excavations reconsidered: a contribution to the discussion of the stratigraphy of the midden at the Norse Niaquusat farm. – Acta borealia 8: 82-92.

Arneborg, J., Heinemeier, J., Lynnerup, N., Nielsen, H. L., Rud, N. and Sveinbjörnsdóttir, Á. E. 1999. Change of diet of the Greenland vikings determined from stable carbon isotope analysis and ^{14}C dating of their bones. – Radiocarbon 41: 157-168.

Arneborg, J., Heinemeier, J., Lynnerup, N., Nielsen, H. L., Rud, N. and Sveinbjörnsdóttir, Á. E. 2002: C-14 dating and the disappearance of Norsemen from Greenland. – Europhysics News May/June: 77-80.

Barret, J. H. 1995. "Few know an earl in fishing clothes". Fish middens and the economy of the Viking Age and Late Norse earldoms of Orkney and Caithness, northern Scotland. – Ph.d. thesis, University of Glasgow, Department of Archaeology.

Barrett, J. H. 1997. Fish trade in Norse Orkney and Caithness: a zooarchaeological approach. Antiquity 71: 616-638.

Barrett, J. H., Nicholson, R. A. and Cerón-Carrasco, R. 1999. Archaeo-ichthyological evidence for long-term socio-economic trends in northern Scotland: 3500 BC to AD 1500. – Journal of Archaeological Science 26: 353-388.

Berglund, J. 1997. Two dogs and a dragon. – In: Gilberg, R. and Gulløv, H. (eds): Fifty years of Arctic research. Anthropological studies from Greenland to Siberia. Publications of the National Museum, Ethnographical series 18: 65-69.

Berglund, J. 1998. The excavations at the Farm beneath the Sand introduction. – In: Arneborg, J. and Gulløv, H.C. (eds): Man, culture and environment in ancient Greenland, report on a research programme. The Danish National Museum and The Danish Polar Center, pp. 7-13.

Berthelsen, C., Mortensen, I. H. and Mortensen, E. (eds.) 1990. Kalaallit Nunaat – Greenland – Atlas. – Pilersuiffik, Nuuk.

Boertmann, D. 1994. An annotated checklist to the birds of Greenland. Meddelelser om Grønland, Bioscience vol. 38. 63 p.

Boessneck, J., Müller, H. H. and Teichert, M. 1964. Osteologische Unterscheidungsmerkmale zwischen Schafe (Ovis aries Linné) und Ziege (Capra hircus Linné). – Kühm Archiv 78: 1-129.

Brinkhuizen, D. C. 1994. Some notes on fish remains from the late 16th century merchant vessel Scheurrak SO1. – In: van Neer, W. (ed.): Fish exploitation in the past: proceedings of the 7th meeting of the ICAZ fish remains working group: 197-206. Musée Royale de l'Afrique Centrale, Tervuren.

Brinkmann, A. 1921. Canidenstudien. – Videnskablige Meddelelser fra Dansk Naturhistorisk Forening 72: 1-43.

Buckland, P. C., Sveinbjarnadóttir, G., Savory, D., McGovern, T. H., Skidmore, P. and Andreasen, C. 1983. Norsemen at Nipáitsoq, Greenland: a palaeoecological investigation. – Norwegian Archaeological Review 16: 86-98.

Buckland, P. C., Amorosi, T., Barlow, L. K., Dugmore, A. J., Mayewski, P. A., McGovern, T. H., Ogilvie, A. E. J., Sadler, J. P. and Skidmore, P. 1996. Bioarchaeological and climatological evidence for the fate of Norse farmers in medieval Greenland. – Antiquity 70: 88-96.

Crockford, S.J. 2000. A commentary on dog evolution: regional variation, breed development and hybridisation with wolves. – BAR International Series 889: 295-312.

Degerbøl, M. 1929. Animal bones fron the Norse ruins at Gardar, Greenland. – Meddelelser om Grønland vol. 76: 183-192.

Degerbøl, M. 1934. Animal bones from the Norse ruins at Brattahlid. – Meddelelser om Grønland vol. 88: 149-155.

Degerbøl, M. 1936. Animal remains from the West Settlement in Greenland with special reference to livestock. – Meddelelser om Grønland vol. 88(3): 1-54.

Degerbøl, M. 1939. Nogle bemærkninger om husdyrene på Island i Middelalderen. – In: Forntida gårdar i Island. Nordiska arkeologiska undersökningen i Island 1939: 261-268.

Degerbøl, M. 1940. Mammalia. – Zoology of the Faroes 3(2) 65: 1-132.

Degerbøl, M. 1941. The osseous material from Austmannadal and Tungmeralik. – Meddelelser om Grønland vol. 89: 345-354.

Degerbøl M. 1943. Vort ældste husdyr, hunden – og dens skæbne i Danmark. – Dyr i natur og museum 1942-1943: 11-36.

Enghoff, I.B. 2002. De fredløses måltider. – In: Engberg, N. and Asingh, P. (eds.): Hjelm og marsk Stig. Narayana Press, Gylling. Pp. 221-243, 296-306, 311-317, 335-338.

Enghoff, I.B. (ms). Pattedyr og fugle fra markedspladsen i Ribe.

Gotfredsen 1997. Sea bird explotation on coastal Inuit sites, West and Southeast Greenland. – International Journal of Osteoarchaeology 7: 274-286.
Gotfredsen, A. B. 1998. The faunal material of the Saqqaq site Nipisat I, Sisimiut district, West Greenland. – In: Arneborg, J. and Gulløv, H.C.(eds): Man, culture and environment in ancient Greenland, report on a research programme. The Danish National Museum and Danish Polar Center, pp 124-132.
Gotfredsen, A. B. 1999. The avifauna of Greenland in a quaternary zoological perspective. An analyses of the zoogeography of selected bird species and prehistoric bird hunting in low arctic Greenland. – Ph.D. Thesis, University of Copenhagen, Zoological Museum.
Grant, A. 1982. The use of tooth wear as a guide to the age of domestic ungulates. – In: Wilson, B., Grigson, C. and Payne, S. (eds.): Ageing and sexing Animal Bones from Archaeological Sites. BAR British Series 109: 91-108.
Grayson, D.K. 1984. Quantitative zooarchaeology. Topics in the analysis of archaeological faunas. – Academic Press, Orlando etc.: xx+202 pp.
Grønnow, B., Meldgård, M. and Nielsen, J. B. 1983: Aasivissuit – the great summer camp. Archaeological, ethnographical and zoo-archaeological studies of a caribous-hunting site in West Greenland. – Meddelelser om Grønland, Man & Society vol. 5, 96 p.
Habermehl, K.-H. 1975. Die Altersbestimmung bei Haus-und Labortieren. – Verlag Paul Parey. Berlin and Hamburg, 216 pp.
Hambleton, E. and Rowley-Conwy, P. 1997. The medeival reindeer economy at Gæccevaj'njar'ga 244 B in the Varanger Fjord, North Norway. Norwegian Archaeological Review 30(1): 55-70.
Hansen, B.U., 2000. Klima. – Topografisk Atlas Grønland. Det Kongelige Danske Geografiske Selskab and Kort- og Matrikelstyrelsen: 26-27.
Hatting, T. 1982. Nordboernes husdyr. Tidsskriftet Grønland 5-6-7: 252-257.
Hatting, T. 1995. Sex-related characters in the pelvic bone of domestic sheep (Ovis aries L.). – Archaeofauna 4: 71-76.
Hatting, T. 1998. Dyreknogler. – In: Hjermind, J., Iversen, M. and Kristensen, H. K. (ed.s): Viborg Søndersø 1000-1300. Byarkæologiske undersøgelser 1981 og 1984-85. Viborg Stiftsmuseums skriftrække 2. Jysk Arkæologisk Selskabs Skrifter 34: 301-308.
Hufthammer, A. K. 1995. Age determination of reindeer (Rangifer tarandus L.). ArchaeoZoologia 7: 33-42.
Kalaallit Nunaat – Greenland – Atlas. – Berthelsen, C., Mortensen, I. H. and Mortensen, E. (eds.). Pilersuiffik, Nuuk.
Kapel, H.C. 1991. Nyopdaget nordbogård I Vesterbygden. – Tusaat – Forskning i Grønland: 8-15.
Legge, A.J. 1992. Excavations at Grimes Graves Norfolk 1972-1976. Fascicule 4. Animals, environment and the Bronze Age economy. – London, Trustees of the British Museum, 87 pp.

Lynnerup, N. 1998. The Greenland Norse – a biological-anthropological study. – Meddelelser om Grønland, Man & Society vol 24, 149 p.

Mainland, I.M. 2001. The potential of dental microwear for exploring seasonal aspects of sheep husbandry and management in Norse Greenland. ArchaeoZoologia 11: 79-100.

McGovern, T.H. 1980. Cows, harp seals and churchbells: adaptation and extinction in Norse Greenland. – Human ecology 8: 245-275.

McGovern, T.H. 1985: Contributions to the Paleoeconomy of Norse Greenland. Acta Archaeologica 54: 73-122.

McGovern, T.H. 1992. The zooaechaeology of the Vatnahverfi. – In: Vebæk, C. L. : Vatnahverfi, an inland district of the Eastern Settlement in Greenland. Meddelelser om Grønland, Man & Society vol. 17, pp. 93-107.

McGovern, T. H., Amorosi, T., Perdikaris, S. and Woollett, J. 1996. Vertebrate zooarchaeology of Sandnes V51: economic change at a chieftain's farm in West Greenland. – Arctic Anthropology 33(2): 94-121.

McGovern, T. H., Bigelow, G. F., Amorosi, T., Woollett, J. and Perdikaris, S. 1993. The zooarchaeology of Ø 17a. – In: Vebæk, C. : Narsaq – a Norse landnáma farm. – Meddelelser om Grønland, Man & Society vol. 18: 58-72.

McGovern T.H., Buckland, P.C., Savory, D., Sveinbjarnardóttir, G., Andreasen, C. and Skidmore, P. 1983. A Study of the Faunal and Floral Remains from two Norse Farms in the Western Settlement, Greenland. – Arctic Anthropology 20: 93-120.

McGovern, T, H. and Jordan, R. H. 1982. Settlement and land use in the inner fjords of Godthaab District, West Greenland. – Arctic Anthropology 19: 63-79.

Meldgaard, M. 1986. The Greenland caribou – zoogeography, taxonomy, and population dynamics. Meddelelser om Grønland, Bioscience vol. 20, 88 p.

Muus, B. 1990: Fisk. – In: Muus, B., Salomonsen, F. and Vibe, C.: Grønlands Fauna. Fisk, fugle, pattedyr: 23-158. Gyldendal.

Møhl, J. 1982. Resourceudnyttelse fra norrøne og eskimoiske affaldslag belyst gennem knoglematerialet. – Tidsskriftet Grønland 8-9: 286-295.

Møhl, U. 1961. Oversigt over dyreknoglerne fra Næsholm. – In: la Cour, V.: Næsholm, pp. 364-429. Nationalmuseet, Copenhagen.

Møhl, U. 1971. Et knoglemateriale fra Vikingetid og Middelalder i Århus. – In: Hellmuth Andersen, H., Crabb, P.J. and Madsen, H.J.: Århus Søndervold, pp. 321-329.

Nicholson, R.A. 1998. Fishing in the northern isles: a case study based on fish bone assemblages from two multi-period sites on Sanday, Orkney. – Environmental Archaeology 2: 15-28.

Nielsen, J.G. and Bertelsen, E. 1992. Fisk i grønlandske farvande. – Atuakkiorfik, Nuuk, 427 pp.

North Atlantic Biocultural Organization 2001. NABO Zooarchaeological Archive. CUNY Northern Science and Education Center NYC.

Nyegaard, G. 1991. Dyreknoglerne fra 1991-undersøgelsen af "Gården under Sandet" J.Nr. KNK 1950. – Unpublished report, Zoological Museum, University of Copenhagen.

Nyegaard, G. 1992: Dyreknoglerne fra de arkæologiske udgravninger af "Gården under Sandet" i 1992. – Unpublished report, Zoological Museum, University of Copenhagen.

O'Connor, T.P. 1989. Bones from Anglo-Scandinavien levels at 16-22 Coppergate. – The archaeology of York. The animal Bones 15/3: 137-207, plates VIII-XI.

Payne, S. 1973. Kill-off patterns in sheep and goats: the mandibles from Aşvan Kale. Anatolian Studies, Journal of the British Institute of Archaeology at Ankara 23: 281-303.

Prummel, W. and Fritsch, H.-J. 1986. A guide for the distinction of species, sex and body side in bones of sheep and goat. – Journal of Archaeological Science 1986 13: 567-577.

Reichstein, H. 1974. Ergebnisse und probleme von Untersuchungen an Wildtieren aus Haithabu (Ausgrabung 1963-1964). – In: Untersuchungen an Tierknochenfunden (1963-1964). Ausgrabungen in Haithabu 7: 103-144.

Reinert, A. 1971. Højere dyr på land. – Danmarks Natur 10: 537-544.

Roussell, Aa. 1936. Sandnes and the Neighbouring Farms. – Meddelelser om Grønland vol. 88(2).

Roussell, Aa. 1941. Farms and Churches in the Mediaeval Norse Settlement of Greenland. – Meddelelser om Grønland vol. 89.

Rowley-Conwy, P. 2000. Milking caprines, hunting pigs: the Neolithic economy of Arene Candide in its West Mediterranean context. – In: Rowlay-Conwy, P. (ed.): Animal Bones, Human Societies: 124-132. Oxford and Oakville, Oxbow Books.

Russell, D. H. 1985. A biogeographical model for island dwarfism of domestic livestock in the Scandinavian North Atlantic: a comparative metrical analysis of Bos and ovicaprid metapodials. – Master's thesis, Hunter College, New York.

Salomonsen, F. 1990: Fugle. – In: Muus, B., Salomonsen, F. and Vibe, C.: Grønlands Fauna. Fisk, fugle, pattedyr: 159-361. Gyldendal.

Schweger, C.E. 1998. Geoarchaeology of the GUS site: a preliminary framework. – In: Arneborg, J. and Gulløv, H.C.(eds): Man, culture and environment in ancient Greenland, report on a research programme: 14-18. Danish National Museum and Danish Polar Center.

Storå, J. 2000. Skeletal development in the grey seal *Halichoerus grypus*, the ringed seal *Phoca hispida botnica* the harbour seal *Phoca vitulina vitulina* and the harp seal *Phoca groenlandica*. Epiphyseal fusion and life history. – ArchaeoZoologia 11: 199-222.

Teichert, M. 1975. Osteometrische Untersuchungen zur Berechnung der Widerristhöhe bei Schafen. – In: Clason, A.T. (ed.): Archaeological Studies: 51-69. Amsterdam.

Tinsley, C. 1999. Zooarchaeology: some preliminary notes. – In: Lucas, G. (ed.): Hofstaðir 1999, Framvindusky´rslur/Interim Report, Fornleifastofnum Íslands, Reykjavik: 75-85.

Tinsley C. 2001. Zooarchaeology of Sveigakot. A preliminary report on the upper midden deposit. – In: Vésteinsson, O. (ed.): Archaeological investigations at Sveigakot 1998-2000: 25-38. Reykjavik, Fornleifastofnum Íslands.

Tinsley, C. (in press). The Viking settlement of northern Iceland: a preliminary zooarchaeological analysis. – Environmental Archaeology.

Vebæk, C.L. 1991. Hunting on land and at sea and fishing in Medieval Norse Greenland. – Acta borealia 8: 5-14.

Vibe, C.. 1990: Pattedyr. – In: Muus, B., Salomonsen, F. and Vibe, C.: Grønlands Fauna. Fisk, fugle, pattedyr: 363-459. Gyldendal.

von Mosczinsky, K. 2001. Vinthundar i arkeologisk kontext – en osteometrisk metod för identifikation. – Unpublished report (Magisteruppsats i Historisk Osteologi), University of Lund.

von Mosczinsky, K. 2002. Ny metod för identifiering av vinthundar. – Benbiten 15, 4 pp.

von den Driesch, A. 1976. A guide to the measurement of animal bones from archaeological sites. – Peabody Museum Bulletin 1, ix + 136 p.

von den Driesch, A. and Boessneck, J. 1974. Kritische Anmerkungen zur Widerristhöhenberechnung aus Längenmassen vor- und frühgeschichtlicher Tierknochen. Säugetierkundliche Mitteilungen 22. Heft 4. pp. 325-348.

Østergard, E. 1998. The textiles – a preliminary report. – In: Arneborg, J. and Gulløv, H.C. (eds): Man, culture and environment in ancient Greenland, report on a research programme. Danish National Museum and Danish Polar Center p. 58-65.

MONOGRAPHS ON GREENLAND

DANISH POLAR CENTER

This book presents an analysis of a large and well-preserved sample of animal bones, which was excavated on "The Farm beneath the Sand" in the Norse Western Settlement in Greenland. A wide range (at least 36 species) of fish, birds and mammals is represented in the material, from tiny capelin over geese and sheep to huge baleen whales. The analysis covers the entire period of occupation of the farm, from ca. AD 1000-1400. It illustrates how the Norsemen exploited the wild fauna but also kept domestic animals, and how the latter adapted to living in the new environment.

Dr. Inge Bødker Enghoff received her Ph.D. from the University of Copenhagen in 1994. Her thesis was about fishing in Denmark during the Ertebølle period based on analysis of extensive samples of subfossil fish bones. Since 1983, she has worked in the Zoological Museum, University of Copenhagen, as a specialist in subfossil animal bones.

Danish Polar Center

SILA
THE GREENLAND RESEARCH CENTRE
AT THE NATIONAL MUSEUM OF DENMARK

Greenland National Museum
& Archives

Printed in Denmark by Special-Trykkeriet Viborg a-s