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The Weichselian (c. 115,000 – 10,000 B.P.) vertebrate fauna of Norway

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ABSTRACT – The oldest Quaternary vertebrate fossils from Norway are seal bones, probably *Phoca vitulina* (common seal) from the Eemian (c. 130,000 – 115,000 B.P.) or the very beginning of the Weichselian. A mammal arctic tundra herbivore megafauna, including *Mammuthus primigenius*, *Ovibos moschatus* and *Rangifer tarandus*, existed in South Norway during both the Lower and Middle Weichselian interstadials (c. 115–85 ka B.P. and c. 70–52 ka B.P.). This fauna was probably distributed over most of the inland, including the high mountain plateau of Hardangervidda, but not in the mountainous areas of the west. At present there is no proof of the existence of an inland fauna during the main Middle Weichselian interstadial, c. 36 – 28 ka. B.P. or any of the subsequent interstadials. However, rich bone assemblages from the north and south coast of Norway document the presence of a coastal arctic fauna from both c. 115–85 ka B.P. and 36–28 ka B.P. The lower interstadial bone assemblages, from northern Norway, include polar bear (*Ursus maritimus*), wolf (*Canis lupus*), polar fox (*Alopex lagopus*), harp seal (*Phoca groenlandica*), birds and fishes, while reindeer (*Rangifer tarandus*) and ringed seal (*Phoca hispida*) are also included in the younger assemblage from south Norway. Both faunas are arctic, however, the oldest of a low arctic coastal environment, the younger of a middle to high arctic, indicating more severe climatic conditions during the youngest interstadial. Except for a bone assemblage from the Bolling interstadial (c. 13–12 ka B.P.) that, based on the composition of bird species, can be regarded as a boreal fauna, all late glacial stray finds are arctic species.

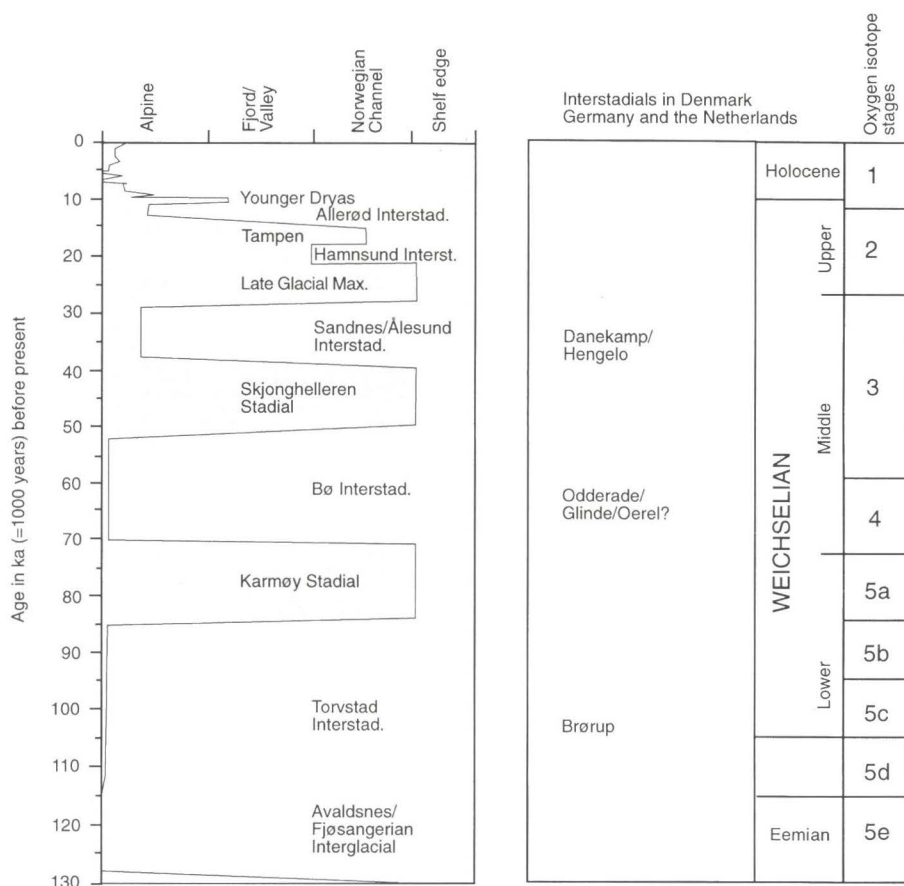
RIASSUNTO – [La fauna a vertebrati del Weichseliano (115,000 – 10,000 B.P.) in Norvegia] – I più antichi resti di vertebrati fossili del Quaternario norvegese appartengono ad una foca, probabilmente *Phoca vitulina*, e risalgono all'Eemiano o al primo Weichseliano. Una fauna a grandi erbivori di tundra (*Mammuthus primigenius*, *Ovibos moschatus* e *Rangifer tarandus*) è vissuta in Norvegia meridionale durante gli interstadiali del Weichseliano inferiore e medio (c. 115–85 ka B.P. e c. 70–52 ka B.P.). Tale associazione era probabilmente distribuita nel paese, incluso l'alto plateau di Hardangervidda, ma non nelle aree montuose dell'area occidentale. Allo stato attuale delle conoscenze, non esiste prova dell'esistenza di complessi faunistici durante l'interstadiale del Weichseliano medio (36 – 28 ka. B.P.) o negli interstadiali successivi. Ricche associazioni fossili nelle aree costiere nella Norvegia settentrionale e meridionale documentano la presenza di una fauna artica nel Weichseliano inferiore e superiore. La prima associazione, Norvegia settentrionale, include *Ursus maritimus*, *Canis lupus*, *Alopex lagopus*, *Phoca groenlandica*, uccelli e pesci; la seconda e più recente fauna costiera, nella Norvegia meridionale, comprende anche *Rangifer tarandus* e *Phoca hispida*. Entrambe le associazioni sono di tipo artico, ma la più recente ha un carattere più spinto, indice di condizioni climatiche più severe durante il Weichseliano superiore. Tutti gli sporadici ritrovamenti dell'ultimo glaciale hanno un carattere artico, ad eccezione di una associazione risalente all'interstadiale Bolling (c. 13–12 ka B.P.) che, sulla base della composizione dell'avifauna, può essere considerata boreale.

INTRODUCTION

Until 30–40 years ago it was generally assumed that Norway was completely glaciated during the last Ice Age [Weichselian, c. 117,000 to 10,000 before present (B.P.)]. Recent geological research has, however, produced a more detailed picture of the Weichselian glacial history and significant chronological fluctuations in the ice cover as well as geographical differences have been proved (e.g. Mangerud, 1981, 1991; Seirup *et al.*, 2000).

There are substantial topographical and climatic variations along the 1780 km length of Norway, from North to South, as well as a strong gradient East to West. Despite these variations it is reasonable to assume that the main elements in the Weichselian glacial history hold true for the country as a whole, thus, if a major ice free interstadial can be traced in the southern part of the country it is likely that there were also interstadial conditions in the north. Thus a review of the glacial events from southwestern Norway

(Seirup *et al.*, 2000) can be extended generally over the whole of Norway (Text-fig. 1). They conclude that, in southern Norway, the Eemian interglacial (c. 130,000 – 115,000 B.P.) was succeeded by relatively long-lasting interstadial conditions, with restricted glaciation, before the first major Weichselian advance onto the shelf around 80 ka B.P., the Karmøy Stadial. Between 80 and 60 ka B.P., probably closer to the highest estimate, the Bø Interstadial has been detected. This was followed by the Skjonghelleren Stadial, when the glacier again reached the Norwegian shelf. A new Interstadial occurred around 38 ka and lasted for about 10,000 years. During the subsequent stadial (28–22 ka) there was contact between the Fennoscandian and the British ice in the North Sea and this period is assumed to be the Weichselian Maximum. During the later part of Upper Weichselian, until the Holocene deglaciation, some 10,000 years ago, large fluctuations in the Ice extent occurred, but by 13,000 years B.P. significant areas along the Norwegian coast were deglaciated.



Text-fig. 1 - Glaciation curve for south-western Fennoscandia during the last 150,000 years. Adapted after Seirup *et al.*, 2000, fig. 9 and slightly revised.

The centre of the 2-3 kilometre thick Weichselian Scandinavian Ice sheet was in the Gulf of Bothnia. Although recent research have proven that the Ice sheet covering Scandinavia during stadials was probably thinner than previously estimated, even with nunataks (Nesje *et al.*, 1988, 1994, Olsen *et al.*, 2000), it is certain that most Quaternary deposits were removed or buried deep by the advancing glacier during the stadials. Thus, except in caves and sub-till sediments, very few Weichselian fossils have been found in Norway. Therefore this attempt to establish the vertebrate faunal history of the Last Ice Age can be compared to solving a puzzle when most of the pieces are missing.

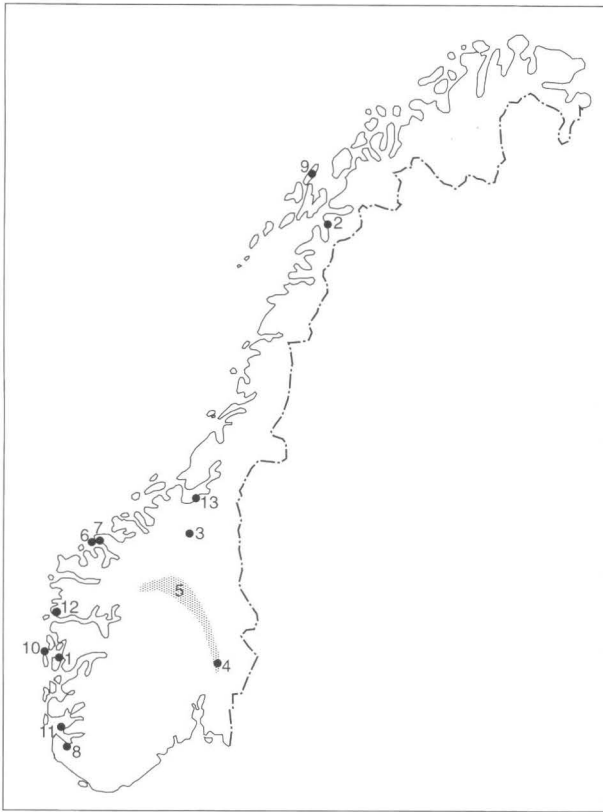
MATERIAL

Most of the fossil bones have been found in caves, where they have been protected from glacial erosion. Two types of caves have produced significant Weichselian vertebrates remnants, karst caves in the North of Norway and abrasion marine caves at the North-western coast of southern Norway (Text-fig. 2). In addition, some bones have been found in sub-till sediments, in particular in eastern Norway. The bones from the caves and a few of the sub-till sediments have

been excavated by geologists, in general in cooperation with zoologists, while most of the till finds are stray finds, collected from gravel pits or ditches. For the latter it has rarely been possible to establish the stratigraphical context to which the bones belong.

THE EEMIAN AND LOWER WEICHSELIAN VERTEBRATE FAUNA

One of the first remnants of a Eemian/Lower Weichselian vertebrate fauna was found by Mangerud (1970). At Fjøsanger (Text-fig. 2), at the western coast of Norway, he excavated what he has argued to be a complete Eemian interglacial sequence overlain by Early Weichselian sediments (Mangerud *et al.*, 1981). A concentration of seal bones was found in fossil-bearing, short-transported or parautochthonous marine sediments. A pollen and spore sample taken in immediate contact with the seal bones, in presumably undisturbed remains of marine sediments, indicates the presence of a dense *Picea* forest, that also included *Pinus* and *Ilex*. Mangerud *et al.* (1981) used the presence of forest as well as radiocarbon dates exceeding 40,000 years (in reality infinite age), to argue that the sediments must be of Eemian or a fairly warm interstadial origin. He concludes that



Text-fig. 2 - Location map of sites producing fossil bones. 1-7: Lower and Middle Weichselian sites. 8-13: Upper Weichselian sites. 1) Fjøsanger. 2) the Nordcemgrotta cave. 3) Indset, Dovre. 4) Hauer seter. 5) Mammoths. 6) the Skjonghelleren cave. 7) the Hamnsundhelleren cave. 8) Gravern. 9) Andøya. 10) Blomvåg. 11) Finnøy. 12) Helle gravel pit. 13) Nidaros gravel pit. All sites are mentioned in the text.

the pollen, in particular the presence of *Ilex*, makes late Eemian the most likely age also for the seal bones in the till above the Eemian layer. (Mangerud, 1970).

At present the bone material includes 6 costas, 2 vertebrae and 3 costas or vertebrae, all quite fragmented (Text-fig. 3). However, at least 5 of these breaks are caused by secondary fragmentation, during or after the excavation. The zoologist Håkon Olsen was able to identify the bones as belonging to seals (Phocidae), but not to genus (Mangerud, 1970). In revising the material I have been able to get a little further with the identification: Three of the costas are particularly well preserved, with the head as well as some of the curving body present. In all three both the joint facets and the tubercle facets are missing, and thus they have clearly belonged to a juvenile or a sub-adult individual. The morphology suggest that these are left ribs number 8, 9 and 10. Both the stage of development of the bone elements as well as the sequence of successive ribs strongly suggest that all the bones from Fjøsanger belong to one individual.

Amongst the seals of the northern hemisphere they are morphologically absolutely closest to the species within the genus *Phoca* (Wilson & Reeder, 1992), and in particular to *Phoca vitulina* (common seal/harbour seal). However, the ribs are slightly larger than those of a modern harbour seal, more of the size as a small sub-adult *Phoca groenlandica* (harp seal). Today the Harbour Seal has a very wide north-south distribution at the coasts of the eastern Atlantic Ocean, from Finnmark (71° N) and the northern coast of Iceland in the north to Portugal (41° N) in the south (King, 1964). The Harp Seal has, however, an Arctic distribution, from approximately 71° N and as far North as there are open waters (King, 1964).

In northern Norway, Lauritzen (1998) has investigated the stratigraphy of several of the many karst caves in Nordland county and the southern part of Troms county. Fossiliferous sediments are generally rare in these caves, but from the Nordcemgrotta, Kjøpsvik (Text-fig. 2) a sample of approximately 450 bone fragments has been collected. The cave is a part of a conduit which leads to a paleospring. It is almost completely filled with sediments that have been transported from deeper inside the cave system towards the spring. The more than 13 m thick deposits consist of sand, gravel and diamictic sediments (Lauritzen *et al.*, 1996).

In the sedimentation choke two separate, but correlated sections, have been excavated. One section was excavated to the depth of 13 m, the other to 5 m, but neither of the excavations reached bedrock. Based on ^{14}C dates of the bones and the $^{230}\text{Th}/^{234}\text{U}$ dates on the calcareous concretions, two bone bearing horizons were recognised; the *Ursus* horizon containing bones older than 70 ka and a 22 ka old *Ursus maritimus* horizon.

From the *Ursus* horizon Lauritzen *et al.* (1996) reported bones of the mammals *Ursus* sp., *Ursus maritimus*, *Canis lupus*, *Alopex lagopus*, *Vulpes vulpes*, *Martes martes*, *Microtus agrestis*, *Lemmus* sp., the birds *Somateria* sp., *Phalacrocorax carbo*, *Lagopus mutus*, and the fish *Gadus morhua*.

According to Lauritzen *et al.* (1996) the fauna can be separated into two faunal complexes: an arctic (ice-contact) and a more temperate (forest) fauna. In the former group they include the polar bear, arctic fox, the birds and also harp seal, while the latter complex includes the pine marten, the short tailed vole and, "to some degree", the wolf. They suggest that the faunal elements from two different climatic episodes might have been mixed during sedimentation or that a climatic development took place during the fossil deposition and that the fauna represents an interstadial or an interglacial/interstadial transition, prior to 70±8.5 ka B.P.

They might well be right in their conclusions, but I am not convinced. The "forest fauna" is made up of two species, the short-tailed vole and the pine marten. Both these species are represented by only

one bone each, and both bones have now been destroyed for the purpose of radiocarbon dating. In the original bone identification lists, both the short-tailed vole (a pelvis) and the pine marten (a caudal vertebra) have question marks. The fact that neither the pelvis nor the caudal vertebrae are good diagnostic bones, and the uncertainty of the identification by the zoologist give good reasons to question if the two species and thus the "forest fauna" are represented in the *Ursus* horizon. It is, however, highly likely that Lauritzen *et al.* (1996) are correct when suggesting that it represents an interstadial fauna. The fauna is that of a sub-arctic/arctic climate and all the species, except for the polar bear, might be found today at the very north of mainland Norway, at least seasonally.

The fauna of the Nordcemgrotta cave is the only Lower Weichselian faunal complex that has been excavated in Norway. From further south in the country there are only stray finds. A interesting such find is a very well preserved cervical vertebra of *Ovibos moschatatus* that was found while constructing a railway at Indset, Dovre (Text-fig. 2) (Reusch, 1913). The vertebrae was found in gravel, underneath a sand layer that was covered by till (Bjørlykke, 1913). A tentative radiocarbon dating of the bone produced an infinite age, older than 40 ka. Thus the musk ox might have been a part of the fauna of the Bø interstadial (52-70 ka) or the Torvstad interstadial (85-115 ka) (Text-fig. 1).

In general, the early Weichselian vegetation history of Norway is poorly known. However, a pollen diagram from SE Norway, correlated with Brørup, shows a succession from an initial *Betula* dominance, to an assemblage of conifers such as *Picea* and *Larix* with a dominance of *Pinus*, and in the younger part of the interstadial, an increase of non-arboreal pollen (Helle *et al.*, 1981). Mangerud (1991) argues that the combined lithostratigraphy (till/peat/till) and the pollen stratigraphy of the Brumunddal site show a full environmental or climatic cycle: glaciation / tundra / birch forest / tundra / glaciation. It is in general assumed that the Torvstad/Brørup Interstadial was slightly warmer than the younger Bø/Odderade Interstadial (Donner, 1995, pp. 56,58). The most probable vegetation during the colder part of the Torvstad Interstadial and of the Bø Interstadial was arctic tundra. Thus, the musk ox would have found suitable conditions in both interstadials.

Although *Rangifer tarandus* was, and is, a natural element of the arctic tundra of Eurasia, there is only one Early or Middle Weichselian find of the species in Norway, a fragment of an antler. The fragment was found in a gravel pit in an early Holocene ice-marginal delta 205m above sea level (m.a.s.l.), at Hauerseier, southeast Norway. A radiocarbon date produced the age 40,000 +3,900 -2,600 B.P. (Østmo, 1971, pp. 138-139, 271, Nydal *et al.*, 1972), but as the sample was only pre-treated by the HCl-method the date only gives a minimum age (Mangerud, 1981).

Mammuthus primigenius, a Weichselian character species, makes up the majority of mammalian stray finds from Norway, in total 6 molars, 10 tusks, 2 scapulas, 1 ulna, 1 neural spine and 1 pelvic bone. Two of the tusks are probably fragments of one tooth and the two scapulas fragments of the same bone, thus the total of mammoth "sites" from Norway adds up to 19. Seventeen of the sites are within the valley Gudbrandsdalen and two in the fluvial basin of the Gudbrandsdalslågen, the river that flows through the valley (Bergersen, 1991). The majority of sites are found at altitude 200-400 m.a.s.l., that is from the valley floor or at lower slopes. There is, however, also one find from the mountains, a well preserved molar from 950 m.a.s.l., at Skarvang in Vågå. Both the preservation of most of the mammoth finds, as well as the sediments in which they are found makes it unlikely that the fragments have been long transported, in to the valley. On the contrary, it is highly likely that the mammoth roamed in Gudbrandsdalen. Bergersen (1991) argues that the concentration of mammoth finds in the valley are due to the high frequency of sub-till sediments in that region. As mentioned earlier, most of the older Weichselian sediments in Norway have been removed by the ice or buried. There are several areas in Norway that probably would have provided suitable conditions for the mammoth during an interstadial, such as the valleys of eastern Norway, the Hardangervidda high mountain plateau and the areas of mid-Norway. Thus, I consider it very likely that the mammoth was distributed over most of the middle and southern part of Norway, with a possible exception of the mountainous areas of western Norway.

Seven of the mammoth finds have been radiocarbon dated, and produced ages between 40,000 and 50,000 B.P. However, as the radiocarbon method has its limit at about 40,000 B.P. the dates only give a minimum age of 40,000 years for these fragments. One find produced a younger age. A very eroded tusk, found in till/sub-till at Hugalia, Kvam, has been dated to 24,400 ± 400 B.P. (Heintz *et al.*, 1979) The reliability of this date has been much discussed, and it is generally concluded that the date only represents a minimum age and that the probable age is much higher (Heintz *et al.*, 1979; Mangerud, 1981). Until recently most scientists considered it unlikely that inland areas of Norway were deglaciated later than 60 ka B.P. Newer dates, e.g. by the thermoluminescence method (TL) which gave a date of 37.4 ka on wind-blown sand from the valley of Gudbrandsdalen (Bergersen, 1991) and the Uranium-series (U) datings that have been carried out by Lauritzen on speleothems from the karst caves in Nordland (cited in Mangerud, 1991) might however change that picture. Thus it might be that central areas of Norway were also deglaciated in periods younger than the Bø Interstadial. However, until more results have been obtained and a mammoth bone produces finite radio-



Text-fig. 3 - The seal bones from the Fjøsanger site, probably Eemian age. The two ribs to the right are of a recent, adult *Phoca vitulina* (common seal). Photo S. Skare ($\times 0.7$).

carbon age, we have to conclude that the mammoth belonged to the Early or Middle Weichselian fauna of Norway.

The inland was covered by ice during the late Middle Weichselian. However, investigations from the coast have produced abundant bone materials, from geological excavations in the abrasion caves of north-western Norway, Skjonghelleren (Larsen *et al.*, 1987) and Hamnsundhelleren (Valen *et al.*, 1996) (Text-fig. 2). From sediments that have been dated by the ^{14}C and the $^{233}\text{Th}/^{234}\text{U}$ methods to approximately 30 ka B.P. (the Ålesund Interstadial) in the Skjonghelleren cave, nearly 7,000 bone fragments have been collected (Larsen *et al.*, 1987). From contemporary sediments (36-28 ka) in the Hamnsundhelleren cave, more than 15,000 bone fragments have been analysed (Valen *et al.*, 1996). The species assemblages of the two caves are presented in table 1. The auks, especially the little auk, are the dominating species in both assemblages, and a high percentage of chicks and young birds in the Hamnsundhelleren

cave indicate that there were breeding colonies in the vicinity. Seals, including many bones of ringed seal pups, are the most common mammals in Hamnsundhelleren, while arctic fox dominates in Skjonghelleren.

Human activity is not documented in any of the interstadial sediments. At present the materials are regarded as natural assemblages of bones, probably mainly remnants of preys and pellets of the arctic fox that was feeding on large sea bird breeding colonies in talus slopes and cliffs near the caves (Larsen *et al.*, 1987, p. 286; Valen *et al.*, 1996, p. 197). In general the fauna complexes of both caves show strong resemblance to a modern arctic coastal fauna, for instance that of Spitsbergen in the archipelago of Svalbard, at 77°N (Tab. 1). The presence of *Alca torda* and *Lutra lutra* are, however, indicative of a slightly more southern fauna or that of climatic changes during the interstadial.

The Hamnsundhelleren and Skjonghelleren bone assemblages are exceptional, as a matter of fact a whale bone from the Gravern clay pit at the south-western coast (Text-fig. 2) is at present the only bone

Species	Skjonghelleren Cave	Hamnsundhelleren Cave	Svalbard, recent fauna
Pisces			
Gadidae non-polar codfishes		x	x
<i>Gadus morhua</i> (Cod)	x		x
<i>Boreogadus saida</i> (Polar-cod)		x	x
<i>Pollachius virens</i> (Pollack)	x		
<i>Brosme brosme</i> (Cusk)	x		x
<i>Anarhichas lupus</i> (Atlantic wolffish)	x		x
Cottidae (Bull-heads)		x	x
<i>Myoxocephalus scorpius</i> (Shorthorn sculpin)	x		x
Pleuronectidae (Flounders)		x	
Aves			
<i>Fulmarus glacialis</i> (Fulmar)	x	x	x
Branta/Anser (Geese)	x	x	x
<i>Somateria mollissima</i> (Eider)		x	x
<i>Somateria spectabilis</i> (King eider)	x	x	x
<i>Melanitta nigra</i> (Common scoter)		x	
<i>Melanitta fusca</i> (Velvet scoter)		x	
<i>Clangula hyemalis</i> (Long-tailed duck)		x	x
<i>Lagopus lagopus</i> (Willow grouse)		x	
<i>Lagopus mutus</i> (Ptarmigan)	x	x	x
<i>Stercorarius parasiticus</i> (Arctic skua)	x		x
<i>Calidris maritima</i> (Purple sandpiper)			x
<i>Larus canus</i> (Common gull)	x		
<i>Rissa tridactyla</i> (Kittiwake)	x		x
<i>Pagophila eburnea</i> (Ivory gull)	x		x
<i>Uria</i> sp. (Guillemots)	x	x	x
<i>Uria aalge</i> (Guillemot)	x		x
<i>Uria lomvia</i> (Brünnich's guillemot)	x		x
<i>Alca torda</i> (Razorbill)		x	
<i>Cepphus grylle</i> (Black guillemot)	x	x	x
<i>Alle alle</i> (Little auk)	x	x	x
<i>Fratercula arctica</i> (Puffin)	x	x	x
<i>Plectrophenax nivalis</i> (Snow bunting)		x	x
Mammalia			
<i>Alopex lagopus</i> (Arctic fox)	x	x	x
<i>Lutra lutra</i> (Otter)	x		
<i>Phoca hispida</i> (Ringed seal)	x	x	x
<i>Phoca groenlandica</i> (Harp seal)		x	x
<i>Erignathus barbatus</i> (Bearded seal)		x	x
<i>Ursus maritimus</i> (Polar bear)		x	x
<i>Rangifer tarandus</i> (Reindeer)		x	x
<i>Lemmus lemmus</i> (Norway lemming)	x		

Tab. 1 - The species composition c. 30 ka B.P. in the Skjonghelleren cave (Larsen *et al.*, 1986) and c. 36-28 ka B.P. in the Hamnsundhelleren cave (Valen *et al.*, 1996). The column to the right denotes which of the species that are common in the recent coastal fauna of Svalbard, the high arctic archipelago of the western Barents sea.

that probably can be assigned to the same interstadial period as the cave finds (Andersen *et al.*, 1981). The bone has been ^{14}C dated to $28,900 \pm 800$ B.P., but Andersen *et al.* (1981) argue that the date probably is too young and assume the real age to be slightly younger than 38 ka.

THE UPPER WEICHSELIAN VERTEBRATE FAUNA

In the Hamnsundhelleren cave a younger and shorter interstadial than the Ålesund Interstadial has been identified, the Hamnsund Interstadial. Its only recognised by the ^{14}C dates (Valen *et al.*, 1996). Thus, except for one bone of *Phoca* sp., dated to $24,387 \pm 960$ B.P., and a bird bone, probably *Alle alle*, dated to

$24,555 \pm 675$ B.P., the species that are associated with that interstadial are unknown.

From the Nordcemgrotta cave Lauritzen *et al.* (1996) report the date of 22 ka B.P. from an ulna of *Ursus maritimus*.

Several investigations on the climate history and palaeoecology for the period 20-11 ka B.P. exist in the same region of northern Norway as the Nordcemgrotta cave, from bore-cores of three lakes on the island of Andøya, (Foged, 1978; Vorren, 1978; Vorren *et al.*; 1988; Alm & Willassen, 1993). Vorren *et al.* (1988) conclude that the climate from c. 19,500 B.P. was fluctuating; from low - middle arctic conditions, to a short glacial advance followed by a middle/low arctic climate and, from c. 18,000 - 16,000 B.P. dry

(continental) high arctic (polar desert) conditions. The period c. 16,000 – 13,700 commenced with a marked climatic amelioration of a maritime type and, in general, the period was relatively mild. From the same period Fjellberg (1978) reports the find of one well preserved vertebra of *Mustela ereminea* (weasel). The bone was found in a stratum that has been dated to c. 15,000 B.P. and associated with vegetation described by Vorren (1978) as arctic and tundra-like, characterised by grasses and small crucifers.

A marked climatic amelioration c. 12,800 B.P. (the beginning of the Bølling Interstadial) has been recognised by geological and vegetation studies, especially from coastal areas (i.e. Mangerud *et al.*, 1979; Moe *et al.*, 1996, pp. 170, 185, 198). From the western coast of southern Norway, at Blomvåg, one bone assemblage has attracted much archaeological attention, as being the possible earliest human occupation site in Norway (Johansen & Undås, 1992). Very well preserved bones were found in clayey silt underneath moraine (Undås, 1942). Radiocarbon dates of the bones have produced ages of i.e. 12,670±350 B.P. and 12,200±350 B.P. (Mangerud, 1977) and 11,603±85 B.P., 12,240±75 B.P. and 12,645±95 B.P. (submitted to radiocarbon dating in 1996 by E. Eriksen), indicating that the bones have been deposited in several events.

Out of a total of 260 bones, 3 mammal, 16 bird and 4 fish species have been identified (Lie, 1986). Anatids, in particular *Somateria mollissima* and auks are the dominating birds. In some aspects the species combination is similar to that of Hamnsundhelleren and Skjonghelleren, however, the absence of little puffin and the presence of *Pinguinus impennis* (great auk) and *Corvus corax* (raven) indicate more boreal climatic conditions than in the Ålesund interstadial. The fishes, cod (*Gadus morhua*), pollack (*Pollachius virens*), plaice (*Pleuronectes platessa*) and sculpin (Cottidae) supports the conclusion of a more boreal climate. *Rangifer tarandus*, *Phoca groenlandica* and whale (probably *Balaena mysticetus* greenland whale) represent the mammal group. The total of 123 mammalian bones probably represent one, at most two, individuals of each species.

Whale bones, contemporary to the Blomvåg bones or somewhat younger, have been reported from several coastal sites (i.e. Anundsen 1977; Blystad, 1983; Sveian & Olsen, 1990). Though none of these have with confidence been identified to the level of species, by morphology and size of the bones, it is highly probable that they are greenland whale bones.

Based on palaeoecological investigations from western Norway Birks *et al.*, (1993) suggest a local mean July temperature of 10–13° C, only slightly cooler than today (13.5° C), during the Allerød, ca 11,000 yr B.P. Though the climatic conditions at that time were suitable for a boreal fauna the vertebrate remains are scarce, only a few whale bones and one humerus of kittiwake (*Rissa tridactyla*).

Through the Younger Dryas (c. 11,000 – 10,000 B.P.), the very cold period that marks the end of last ice age, only a narrow strip of land was ice-free along the coast (i.e. Andersen *et al.*, 1995).

As the mammoth was a characteristic species of the Weichselian arctic tundra, the polar bear can be considered a characteristic species of middle and high arctic coastal environments. Thus, it fits very well that the youngest Weichselian find that have been dated (10,660±80 B.P.) from Norway is an almost complete skeleton of a polar bear. The skeleton was found in, mostly silty, marine gyttja at Finnøy, the very southern part of the west coast (Blystad *et al.*, 1983). *Phoca hispida* is another indicator of middle to high arctic conditions. Two finds of the species, from tills at Nidaros gravel pit in Sør-Trøndelag (Øyen, 1910, pp. 68–69) and Helle gravel pit in Sogn og Fjordane sum up the bone finds of the Younger Dryas, and of the Weichselian in Norway.

CONCLUSIVE REMARKS

The oldest Quaternary vertebrate fossils are seal bones, probably *Phoca vitulina* from the Fjøsanger site and dating back to the Eemian (130,000 – 115,000 B.P.) or early Weichselian (Text-fig. 2). With the exception of the Late Glacial boreal fauna from the Bølling chronozone (c. 13,000 – 12,000 B.P.), the Weichselian fauna of Norway is that of a high to a low arctic climate. The presence of mammoth, musk ox and reindeer proves that a megafauna existed in the inland of south Norway, probably in both Lower and Middle Weichselian interstadials (c. 115–85 ka and 70–52 ka.). Though no fossils have yet been found, it is probable that other mammals, in particular wolf and horse, were included in that fauna complex. It is more uncertain if the woolly rhino, another characteristic species of the Ice Age, was also on the Scandinavian peninsula. The woolly rhino has been found much further north than south Norway, i.e. the Byzovaya site of northern Russia (Kuzmina, 1971) but not in Sweden (Liljegren & Lagerås, 1993), which borders Norway. So far there is no documentation of an inland Upper Weichselian fauna.

However, rich bone assemblages from the north and south coast of Norway document the presence of a coastal arctic fauna, from both c. 115–85 ka B.P. and 36–28 ka B.P. The oldest bone assemblages, from northern Norway, include polar bear, wolf, polar fox, harp seal, birds and fishes, while reindeer and ringed seal are included in the younger, from south Norway. Both faunas are arctic, the oldest is that of a low arctic coastal environment, the younger of a middle to high arctic, indicating more severe climatic conditions during 36–28 ka B.P. than 115–85 ka B.P. The presence of reindeer and *Lagopus* species strongly suggest that larger areas than just the coastal cliffs were deglaciated during these interstadials.

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