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Animal remains from the post-glacial warm period in Norway

ROLF W. LIE

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Bone material excavated in 1954 at a cave on the island of Sandsøya, Sunnmøre, W. Norway is described. The material consists of c. 70 000 bones, including 124 species of birds, and has been dated to c. 6600 to 3600 years B. P. The find is unique in Norway as regards the variety of bird species identified. The climate and environment prevailing in this period are discussed in relation to the habitat requirements of the various species.

Rolf W. Lie, Zoological Museum, N-5007 Bergen, Norway.

INTRODUCTION

A large amount of skeletal remains of vertebrates has been excavated in Norway during the last hundred years, mainly collected by archaeologists during excavation of dwelling sites. A few finds from ice-age deposits have been excavated in cooperation with geologists. At present (1989) bone remains have been excavated and registered from at least 800 localities. Many of these finds are large. Thus excavations in Oslo and Trondheim have produced bone material that must be reckoned in tons. The material from each of several such sites in these towns amounts to more than 100,000 bones. A 3000 year old find from Finnmark (Gamvik) consists of over a million bones, and somewhat older material from Kåtedalen on Radøy in Nordhordland is still larger. All these large finds of bones are an important, and at present to a large extent the only, source of knowledge of the vertebrates of the Quaternary period in Norway. But even though most of these bone finds have been investigated and identified as to species, only a few have been published, and, excluding finds from the Middle Ages, very few have been satisfactorily dated.

We have little information about the animal life in Norway during the first 2000 years after the end of the ice-age. We know rather more about the fauna of the Atlantic and Subboreal periods, i.e. from c. 8000 to 2500 years before present. This is due mainly to the bone material from Vistehola, Jæren (c. 8000 bones) and Skipshelleren in Nordhordland (c. 175,000). Thus in Vistehola, where the

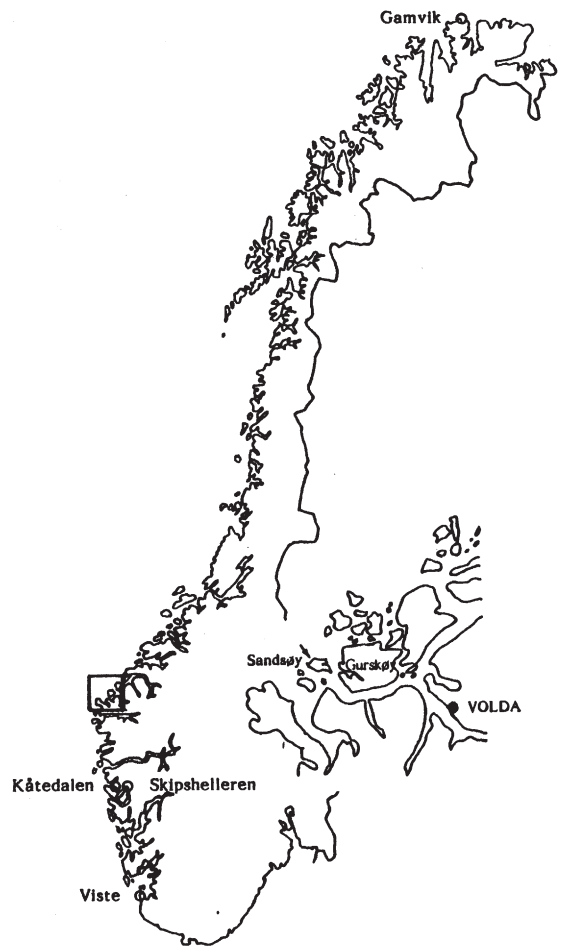

Fig. 1. A key map of Norway. The southern part of Sunnmøre with Sandsøy in the inset is enlarged.

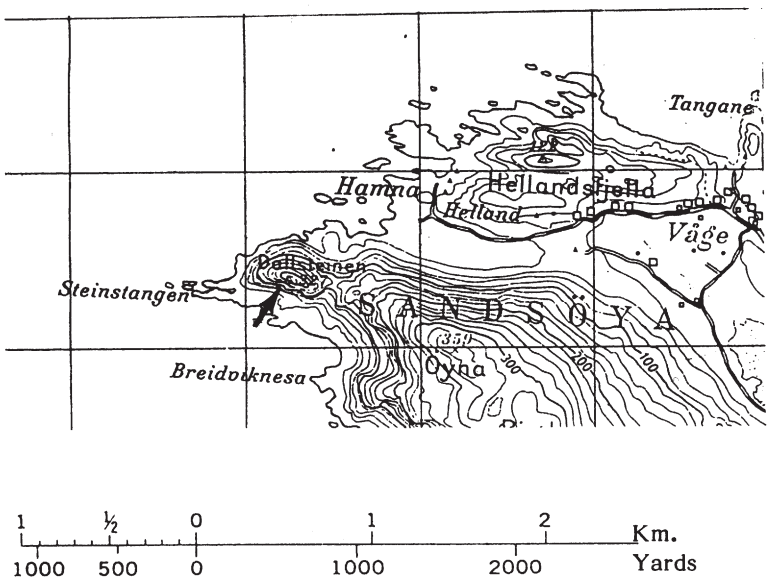

Fig. 2. Map of the western part of Sandsøy. The cave opening is marked with an arrow.

oldest layer has been dated to c. 8000 years BP (the youngest dating is c. 4500 BP), bones of Wild Boar *Sus scrofa* and Wild Cat *Felix catus* have been found, species that are no longer present in the Norwegian fauna (Brøgger 1908, Engenes-Lund 1951). The Elk or Moose *Alces alces* is richly represented in the deepest layers (Atlantic period) both in Vistehola and Skipshelleren (dating: c. 6000—2500 BP) (Olsen 1976), but rather more sparsely in the upper layers (Sub-boreal period). Large numbers of bones of Red Deer *Cervus elaphus* have also been found in the two dwelling sites, but most in the upper layers. Of interesting bird species that are represented in the finds from the dwelling places we must first and foremost mention the Black-necked Grebe *Podiceps nigricollis* which was identified from the deepest layers in Vistehola. Today this species is not known to breed in Norway. In the two mentioned dwelling places the bones of Capercaillie *Tetrao urogallus* and Great Auk *Pinguinus impennis* were also found. The Capercaillie in now very scarce in western Norway, and the Great Auk is extinct. It therefore seems clear from these finds that the fauna in W. Norway has changed since Vistehola and Skipshelleren were used as dwellings. But the material from these two localities comprises relatively few of the species which today constitute the Nordic fauna. It is presumably characterized by the food choice of the inhabitants of the dwelling or of other hunters. In particular there is a discrepancy between the number of bird species represented in Viste and Skipshelleren and the diversity which we must suppose has characterized bird life at these two places at a time when the climate was considerably better than today. About 35 birds species have been identified in the material from Viste, and in Skipshelleren, where the hitherto most species-rich subfossil bird material was excavated, the bones of 48 birds were found. But what we call «small birds» are largely lacking in the material from these localities, just as in other subfossil material. Nevertheless our experience shows that more bird species are represented in material from caves and under overhanging rocks than in material from open dwelling sites, and their composition seems to indicate that those who collected the material in caves and overhangs had more extensive hunting ranges (Hufthammer 1987). Moreover the material from such places spans a longer time period than other material. Can these circumstances be due to other species than humans predatory mammals or birds having left material in caves and under cliffs? In any event such localities do not seem to offer markedly better preservation conditions than open places. Holes under rock overhangs are often greatly exposed to weather, and cave material is concentrated around the opening.

The need has long been felt for a site with undisturbed layers from human activity, which could be excavated following well-planned methods, with a thorough and meticulous registration of material. And it has become clear that it is in the material from caves and under rock overhangs that one must seek additional information about the fauna of the warm period. From this point of view the find at Dollsteinhola can be an important supplement to our understanding of the faunal history of western Norway. It represents an area where we have not had any skeletal finds of interest from the Stone Age. Unfortunately there exists some uncertainty concerning the excavation and collection of material, but this does not necessarily reduce its information potential.

The main aim of this paper is to present the results of the species identification of the bone material from Dollsteinhola in the chronological relationship which follows from the datings that have been made. Starting with the list of species, it is natural to ask what part the different species have played in Sunnmøre during the period covered by the find. In this connection it is desirable to be able to separate representatives of the resident fauna, i.e. species which have obviously lived in the vicinity of the site, from regular and occasional visitors. A somewhat more peripheral, though not unimportant question is what the range of species can tell us about the environmental conditions (climatic and vegetational) in Sunnmøre in the period when the material was deposited at the cave. One must of course take into consideration the fact that vertebrates are not such good indicators of the environment as certain other groups of animals and plants.

MATERIAL AND METHODS

The bone material dealt with here was excavated at the entrance to Dollsteinhola cave in Sunnmøre. The cave lies on the island of Sandsøya at the bottom of the well-known, 227 metre high rock Dollsteinen, a sea-mark which can be seen far from land. The opening of the cave faces south-west, and the excavated area where the material was collected is situated at the entrance to the cave c. 50 m above sea level. From here the «floor» of the cave slopes steeply downwards for about the first 50 m. The length of the cave from the entrance is probably more than 100 m. The

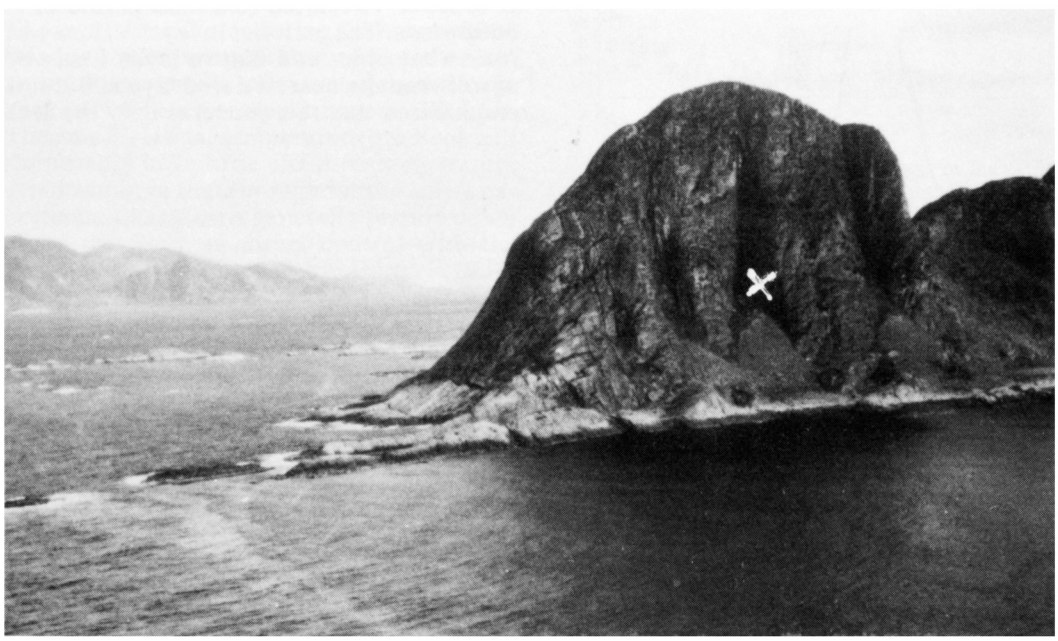

Fig. 3. View of the Dollsteinen with the opening of the cave (cross mark).

material was excavated in 1954 by the archaeologist Erik Hinsch. There exists no report from the excavation with measurements and descriptions of the excavated area and of the stratigraphical conditions. Neither do we have any description of the collecting methods: whether the material represents all that was found in the excavated area, or whether it is a more or less arbitrary sample. We lack therefore an important prerequisite for a thorough analysis of the bone material. But we have nevertheless had the hope that the material could give some information about the collecting methods.

Erik Hinsch became ill immediately following the excavating in Dollsteinhola, and he died in 1960. The material was for many years in the custody of the Historical Museum, University of Bergen, until it was transferred to the Zoological Museum at the same university, and stored under catalogue number J. S. 706.

During the moving of the material it was packed in paper bags which were marked with stratigraphical data and quadrat number. This has obviously been done while the material was being collected. Later (autumn 1988) an inspection was made of Dollsteinhola, in order to try to interpret these data. It seems clear that excavation has been carried out based on a quadratic grid with a unit of 0.5 m in each direction. The layers have been numbered from the top, and in all probability they have all had a depth of 10 cm. Thus the number of a layer gives its lower limit in dm from the surface. The excavated area appears to be about 46 sq.m. and the greatest depth 70 cm (down to and incl. layer VII).

The chronology of the find is based on datings carried out at the Laboratory for Radiological Dating, Trondheim. There are four datings (Table 1). These show that the excavated material belongs to the end of the Atlanticum and the first half of Sub-Boreal time, or in other words the last thousand years of the older stone-age (Mesolithicum), the whole of the younger stone-age (Neolithicum) and part of the bronze-age. A few of the tools that were found also been dated to bronze-age (Ågotnes 1977).

As will be seen, there is close correspondence between the depth from which the samples were taken, and the age of the sample material. This seems to indicate that the layer sequence in the area where the samples were taken (near the cave opening) has not been disturbed. This is an important condition for being able to see the occurrence of the registered species in a chronological relationship. This also means that the material from layer II to layer VI related to a time period of c. 3000 years. The material in layer VII may be somewhat older and that in layer I may be newer than the nearest dated layers. But it is emphasized that this concerns only the area

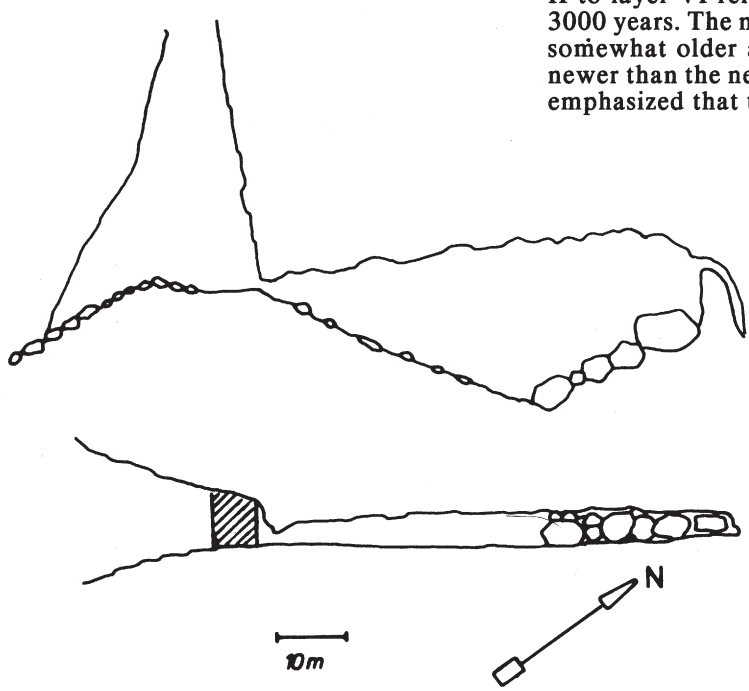

Fig. 4. Longitudinal profile (top) and map of Dollsteinhola (Reusch, 1877). The excavated area is hatched.

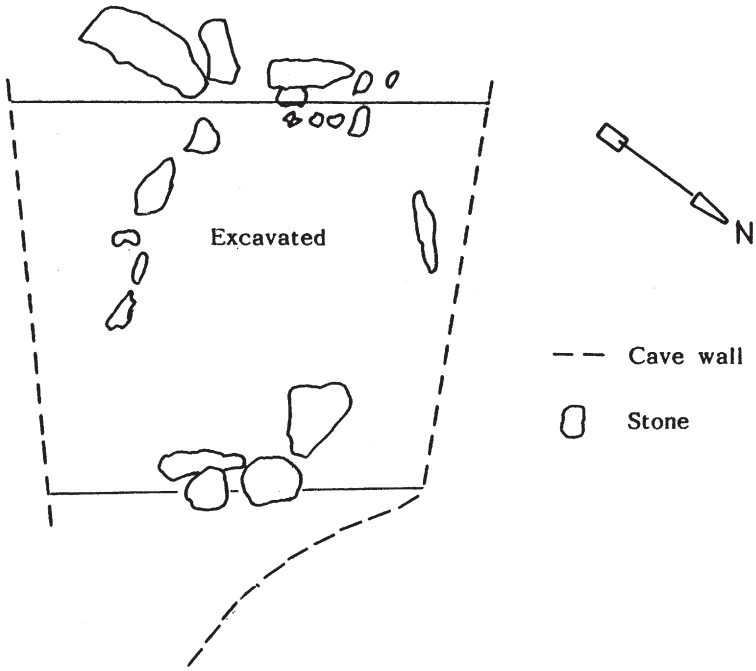

Fig. 5. Map of the excavated area.

at the cave opening from where the dated material was taken. There is reason to suppose that the larger sequence at the outer edge of the excavated area a short way inside the cave opening is reversed. The material in layer VII here, which also includes bones of cattle, gives the impression of being relatively young. The oldest known dating of bones of cattle (from Skipshelleren) is c. 4000 years BP. Above layer I a layer of humus, probably from recent times, had been deposited, and again over this a layer, thick in places, of fresh manure from domestic animals from relatively recent years.

Sandsøya island now has an area of about 12 sq.km. The shortest distance to Kvamsøya (8 sq.km) is c. 2.5 km, while the distance to the considerably larger Gurksøy (39 sq.km) is somewhat less. The vegetation on these islands and the nearest mainland today consists mostly of heather *Calluna vulgaris* with elements of juniper *Juniperus communis* and willow *Salix* sp. The trees that are found here have been planted. In the area by Dollsteinhola on the west side of Sandsøya grazing limits the vegetation to grass and other herbs.

The sea level was higher at the time Dollsteinhola was in use than it is today. The shoreline 6000 years ago (4000 BC) was c. 7 m higher, but in the course of 3000 years the sea sank to c. 4 m above the present sea level. Sandsøya and the neighbouring islands were therefore smaller in this period than they are today, and the distance between them has been correspondingly greater. However, no

Table 1. Datings of bones from Dollsteinhola. The calibrated age (in calendar years) is given following a method developed by Stuiver and Pearson (1986).

Laboratory's no.	Material	Layer	Age BC	Age BP	Radiocarb. Age, uncal.
T-6172	bone	II	1920—1680	3869—3629	3464 ±104
T-6173	bone	III	2485—2209	4434—4158	3886 ± 85
T-6174	bone	IV	4656—4362	6605—6311	5633 ± 94
T-6175	shell	III	2457—2242	4406—4191	3771 ± 75

attempt has been made to calculate how large Sandsøya was 6000—3000 years ago.

The material has been identified to species on the basis of morphological characters, by comparison with recent reference material. In the latter, all Norwegian vertebrate species are represented with several specimens of each sex.

RESULTS

The results of the species identification are shown in Tables 2—4. The tables showing the types of bones that were identified would take up a great deal of space and are therefore omitted. The material comprises c. 70.000 bones and teeth, and fragments of these. The greatest part of the material consists of bones of birds, and small bones and bone fragments are thus characteristic of the material. Few whole bones of larger mammals have been found, while bones of small mammals are mostly unfragmented. Most bones of birds are whole. Also, almost all of the material of fish identified to species consists of whole bones, while the unidentifiable material (of all groups) is mainly fragmentary.

Bones have been identified of 16 mammal species, 124 bird species and 25 fish species. In addition to these there are bones of swallow species Hirundinidae of which species identification has not been possible. In addition, some bones which usually are difficult to distinguish are included under the respective genera, families and orders. Among these there may of course be bones of species which are not on the list.

DISCUSSION

As mentioned, the bones of 16 species of mammals, 124 species of birds and 25 of fish have been identified in the material.

The material comprises rather fewer mammal species than the material from Viste and Skipshelleren. The number of fish species is the same as at Skipshelleren, but more than at Viste. But as regards the number of bird spe-

Table 2a. Number of bones from Dollsteinhula.

Ca. Age BP, uncal..		3460	3820			5630		
Layer no:	1	2	3	4	5	6	7	Total
MAMMALIA								
Homo sapiens Man	2	1		4				7
Bos taurus Cattle	102	280	283	39	1		16	721
Ovis aries/Capra hircus Sheep/Goat	569	690	553	107	10	13	9	1951
Sus scrofa Pig			4					4
Canis familiaris Dog	20				24			44
Sorex araneus Common shrew					1			1
Insectivora		2	5	5	5			17
Plecotus auritus Long-eared Bat			2					2
Chiroptera Bats			3		11			14
Lepus timidus Blue Hare		7	7	15	7	111	13	160
Sciurus vulgaris Red Squirrel			1	19	41	3		64
Rattus sp. Rats					6	3		9
Rodentia	750	706	609	755	1386	91	12	4309
Canidae (Dog, Wolf, Fox)		5		27	3	14		49
Mustela erminea Stoat	1							1
M. putorius Polecat					5			5
Lutra lutra Otter	17	2	7	28	40		3	97
Mustelidae		9	12	8				29
Pusa hispida Common Seal						5		5
Phocidae Seals	7	3	13	11	3	3	9	49
Identified mammal bones	1468	1705	1499	1018	1543	243	62	7538
Unidentifiable mam. bones	1195	2443	2591	247	106	98	48	6728
Total	2663	4148	4090	1265	1649	341	110	14266

Table 2b.

Ca. Age BP, uncal..		3460	3820			5630		
Layer no:	1	2	3	4	5	6	7	Total
AVES								
Podiceps ruficollis Little Grebe	1							1
P. auritus Slavonian Grebe						1		1
Fulmarus glacialis Fulmar	17	3	2	6	3			31
Sula bassana Gannet	10	3	8					21
Phalacrocorax carbo Cormorant	12		5	6				23
P. aristotelis Shag	13			2	3		1	19
Branta leucopsis Barnacle Goose	1							1
Anser anser Greylag Goose			1			1		2
Cygnus olor Mute Swan	2							2
Cygnus sp.	1							1
Tadorna tadorna Shelduck					3			3
Anas platyrhynchos Mallard	2	6	4	8	7	25		52
A. crecca Teal	2	5	2	14	24	1		48
A. penelope Wigeon	5				29			34
Aythya ferina Pochard	1			3				4
A. fuligula Tufted Duck	3			7		3		13
A. marila Scaup						6		6
Somateria mollissima Eider	6	9	2	2	20	36		75
S. spectabilis King Eider				6				6
Melanitta nigra Common Scoter						28	6	34
M. fusca Velvet Scoter		1	5	2	28	27		63
Melanitta sp.	1			1				2
Clangula hyemalis Long-tailed Duck	2	1	4	5	18	20	12	62
Bucephala clangula Goldeneye		1			7			8
Mergus serrator Red-breasted merganser		2					3	5
M. merganser Goosander		1		1		6		8
Anseriformes	9	7	1	20	36			73
Haliaëtus albicilla White-tailed Eagle					2			2
Falco rusticolus Gyr Falcon	1			3	2			6
F. peregrinus Peregrine				1	6			7
F. columbarius Merlin					1	1	1	3
F. tinnunculus Kestrel	10		9	11	4		2	36
Falconidae	1		1	3				5
Lagopus sp. Willow Grouse/Ptarmigan	32	33	25	76	90	94	9	359
Tetrastes bonasia Hazel Hen	5		5	2	26	3		41
Lyrurus tetrix Black Grouse	25	16	21	29	78	9	10	188
Tetrao urogallus Capercaillie	9	5	1	2		2		19
Perdix perdix Partridge		7			3			10
Coturnix coturnix Quail					7			7
Galliformes	1				5			6
Haematopus ostralegus Oystercatcher	4	3	3	10	44	21	2	87
Charadrius hiaticula Ringed Plover						7		7
Pluvialis apricaria Golden Plover	7	3		22	43	2	3	80
P. squatarola Grey Plover						1		1
Vanellus vanellus Lapwing					2			2
Arenaria interpres Turnstone					1	4		5
Calidris minuta Little Stint	3	1	5	2		4	4	19
C. maritima Purple Sandpiper	57	36	18	32	89	23	5	260
C. alpina Dunlin	1		1	3	27	5		37
C. canutus Knot	3	6		4	3	3		19
Philomachus pugnax Ruff			1					1
Tringa totanus Redhank	43	32	9	29	44	25	7	189
T. nebularia Greenshank	3		6	25	40	20		94
T. hypoleucos Common Sandpiper			1			1		2

Ca. Age BP, uncal..		3460	3820			5630		
Layer no:	1	2	3	4	5	6	7	Total
Tringa sp.	2							2
Limosa limosa Black-tailed Godwit				1				1
L. lapponica Bar-tailed Godwit	10	2	5	1	18	2		38
Numenius arquata Curlew				3			1	4
Scolopax rusticola Woodcock	97	73	31	254	237	165	10	867
Gallinago gallinago Snipe			3	1	9	4		17
G. media Great Snipe				8				8
Lymnocryptes minimus Jack Snipe					1			1
Phalaropus lobatus Red-necked Phalarope					3			3
Charadriiformes	11	4	14	21	43			93
Stercorarius skua Great Skua					6			6
S. pomarinus Pomarine Skua				4		1	1	6
Larus ridibundus Black-headed Gull		2	2	20	6	14		44
L. fuscus Lesser Black-backed Gull	8	10	8	91	39	6	2	164
L. argentatus Herring Gull		8	4	109	62	11	26	220
L. marinus Great Black-backed Gull	4	1	1	45	17	4	15	87
L. canus Common Gull	11	7	3	36	28	17	5	107
Rissa tridactyla Kittiwake	8	3	7	5	17	7		47
Sterna sandvicensis Sandwich Tern					3			3
S. hirundo Common Tern	2	2		16	32			52
S. paradisaea Arctic Tern	3	8	9	27	7	31	8	93
Laridae	7		14	2		5		28
Plautus alle Little Auk	252	118	82	57	52	25	4	590
Alca torda Razorbill				4				4
Uria aalge Guillemot	31	19	15	62	50	30	6	213
U. lomvia Brünnich's Guillemot	16	1	1		6	7		31
Cepphus grylle Black Guillemot		11	27	27	63	45	14	187
Fratercula arctica Puffin	94	85	37	160	233	68		677
Alcidae			1				1	2
Columba palumbus Wood Pigeon	3	2	3	15	12	4		39
C. livia Rock Dove	3							3
Cuculus canorus Cuckoo		2		7	9	7		25
Asio flammeus Short-eared Owl	1							1
Surnia ulula Hawk Owl				1		1		2
Strix aluco Tawny Owl		3	1		1	1		6
Picus viridis Green Woodpecker	2	5	5	7	15	2		36
P. canus Grey-headed Woodp.				3				3
Dendrocopus major Great Spotted Woodp.	4	1	1	5	33	3	1	48
Piciformes				1				1
Hirundinidae Swallows	31	7	11	5	48	8		110
Alauda arvensis Skylark					2	1		3
Anthus pratensis Meadow Pipit	10		5		24		6	45
Motacilla flava Yellow Wagtail			1		2			3
M. alba White Wagtail				2				2
Motacillidae						4		4
Sturnus vulgaris Starling	7	24	2	16	93	32	6	180
Garrulus glandarius Jay	1			6				7
Pica pica Magpie	9	4	5		12	7		37
Corvus frugilegus Rook				1				1
C. corone Crow	10	4	3	16	23	7	1	64
C. corax Raven	11	2	7		9	1		30
Bombycilla garrulus Waxwing	2		3		7			12
Troglodytes troglodytes Wren	16	5	7	6	1	3		38
Hippolais icterina Icterine Warbler						1		1
Sylvia atricapilla Blackcap					4			4
Phylloscopus trochilus Willow Warbler					6			6
Phylloscopus sp.			1	2				3

Ca. Age BP, uncal..		3460	3820			5630		
Layer no:	1	2	3	4	5	6	7	Total
Regulus regulus Goldcrest	2			5	2			9
Muscicapa sp. Flycatcher				2				2
Turdus pilaris Fieldfare	63	56	28	118	271	35	12	583
T. torquatus Ring Ouzel	1			9	23			33
T. iliacus Redwing			1	29	19			49
T. philomelos Song Thrush	43	12	19	56	219	24	10	383
T. viscivorus Mistle Thrush				3				3
Turdus sp. Thrush	4	4	5					13
Aegithalos caudatus Long-tailed Tit			5		4	1		10
Parus caeruleus Blue Tit				5	5			10
P. major Great Tit	1			12	12		3	28
Parus sp. Tits	6	3	4					13
Sitta europaea Nuthatch						5		5
Passer domesticus House Sparrow	1		3		10		3	17
P. montanus Tree Sparrow	4							4
Fringilla montifringilla Brambling	5				3	4		12
Carduelis spinus Siskin	2			3				5
Acanthis flavirostris Twite	6							6
Pinicola enucleator Pine Grosbeak		7		4	7			18
Pyrrhula pyrrhula Bullfinch	1		13	29	78	1	13	135
Coccothraustes coccothraustes Hawfinch	2	3	4	13	15			37
Plectrophenax nivalis Snow Bunting				4				4
Passeriformes	49	34	24	38	57	21		223
Aves unidentified	552	444	274	1380	1897	634	72	5253
Juveniles	50	20	33	357	256	67	11	794
Identified bird bones	1751	1177	872	3451	4806	1695	296	14048
Unidentifiable bird bones	876	567	562	1065	975	595	140	4780
Total	2627	1744	1434	4516	5781	2290	436	18828

cies, the find from Dollsteinhola is quite unique even taking into account the large number of bone finds which have been analysed but not published. In the large material from an open dwelling site in Iversfjord, Finnmark (more than 600,000 bones analysed hitherto), which is from the same period as the Dollsteinhola material, there are by comparison only 24 identified bird species, even though that material was sifted during the collecting. This shows what a unique historical faunal document the material from Dollsteinhola represents.

Some other interesting features of the material should be emphasized. The Polecat *Mustela putorius* occurs in our time only in the southernmost part of eastern Norway and even there is quite scarce. In the west Norwegian earth finds it is otherwise only known from Vistehola (c. 8000 years BP). The Long-eared Bat *Plecotus auritus* has not previously been identified in any Norwegian finds of bones, while the other mammal species can be regarded as common in excavated material. All the mammal species except the Polecat occur today in west Norway. In the material from Dollsteinhola the following 7 bones from humans were found: 3 skull bones, 2 vertebrae, 1 fragment of fibula and 1 outer toe joint. Interestingly enough, human bones are very common in excavated material, and were found both in Viste and Skipshelleren.

The large number of bird species that have been identified in the material is undoubtedly of greater interest. Many are not previously represented in Norwegian bone finds. One must however limit oneself to pointing out those most important in relation to the history of the environment and fauna. It must be regarded as surprising that the three species of Galliformes, Capercaillie, Hazel hen *Tetrastes bonasia* and Grey Partridge *Perdix*

Table 2c

Ca. Age BP, uncal..		3460	3820			5630		
Layer no:	1	2	3	4	5	6	7	Total
PISCES								
Squalus acanthias Spurdog		2						2
Pleurotremata			1	14	22			37
Clupea harengus Herring	8	11	35	34	43			131
Salmo salar Salmon					1			1
Salmonidae	4	2		3		1		10
Anguilla anguilla Eel	11	9	14	24	42		1	101
Conger conger Conger	8	20	16	53	173			270
Belone belone Garfish			4	3				7
Merluccius merluccius Hake	9							9
Gadus morhua Cod	1440	292	479	146	214	30	3	2604
Gadiculus argentatus Silvery Pout		2						2
Melanogrammus aeglefinus Haddock	12	30	5	51	65	49	13	225
Merlangius merlangus Whiting		41	1					42
Micromesistius poutassou Blue Whiting		1		3	40			44
Pollachius virens Saithe	702	292	330	90	86	7		1507
Trisopterus minutus Poor Cod	64	41	42	2	3			152
T. esmarki Norway Pout	67	20	15	14	23			139
Brosme brosme Torsk	176	25	99	27	16			343
Molva molva Ling	805	164	253	52	19	1	4	1298
Raniceps raninus Tadpole-fish	29							29
Labrus bergylta Ballan Wrasse	81	64	40	163	353	43	6	750
Scomber scombrus Mackerel	17	11	4	18	18	4		72
Anarhichas lupus Catfish				10	1			11
Sebastes marinus Red-Fish	8	2	1	15	1	2		29
S. viviparus Norway Haddock				19	24			43
Myoxocephalus scorpius Bull-rout	1		3		32			36
Hippoglossus hippoglossus Halibut	4							4
Pleuronectidae		2						2
Heterosomata Flatfishes	15	3	14	4	22	6		64
Unidentified species			1					1
Identified fish bones	3461	1034	1357	745	1198	143	27	7965
Unidentifiable fish bones	13559	3828	6120	1207	1422	211	30	26377
Total	17020	4862	7477	1952	2620	354	57	34342

Mammal bones	14266
Birds bones	18828
Fish bones	34342
Total sum	67436

perdix, are so richly represented in the material. Their biotope is forest, at least for the two firstmentioned, and the Grey Partridge requires fertile fields between woods and scrub. It appears that the Hazel Hen has had its greatest density in early Sub-boreal time, while the Capercaillie has became more common towards the end of this period. Both appear at present to avoid areas with much precipitation, and at least in the Capercaillie the mortality of the chicks increases with precipitation (Moss 1986). The Hazel Hen is dependent on broad-leaved trees with water and watercourses, while the Capercaillie must have pine and the shoots and berries of bilberry *Vaccinium myrtillus* (Moss op. cit.). All three species can be regarded as very stationary. This however is not the case for the Quail *Coturnix coturnix,* and its occurrence in the material has therefore not perhaps the same interest. It has more or less the same habitat requirements as the Grey Partridge.

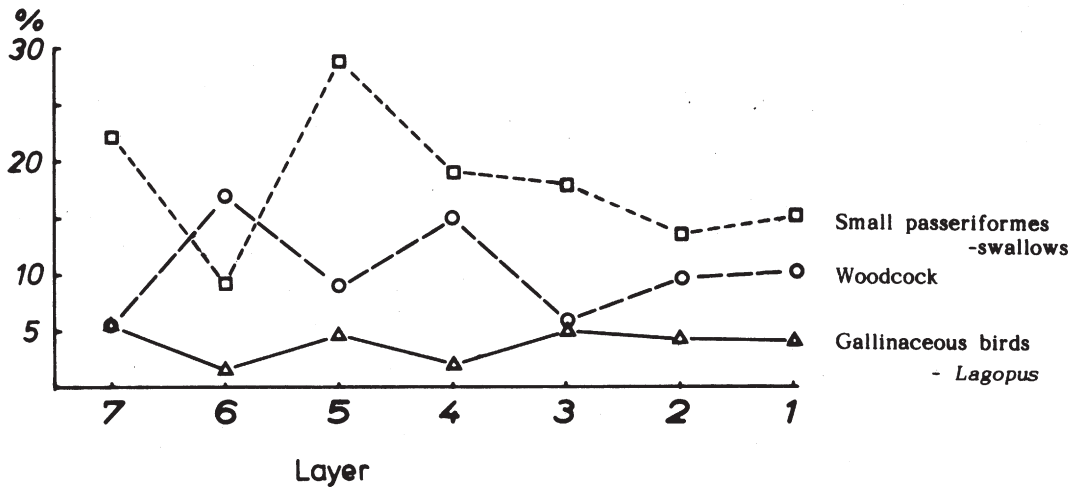

Fig. 6. Variation in relative amount of bones from three groups of birds (percentage of total amount of bird bones within each layer). Small passeriformes exclude the swallows. Gallinaceous birds excludes *Lagopus.*

The berry and seed-eating Hawfinch *Coccothraustes coccothraustes* is rather more interesting, even it strays somewhat outside the breeding season. If it has nested on Sandsøya in early Sub-boreal time, this is probably because there has been an element of mature broad-leaved forest which it prefers. But the bone remains of the Hawfinch can originate from birds that have visited the area in autumn in search of berries. As a whole, a large number of these bird species are attached to forest, and prefer a luxuriant forest environment. This applies to a large extent to thrushes and finches (larger passerines) which in summer and autumn feed on fruit and berries. This also applies to the Woodcock *Scolopax rusticola* which belongs to the wetter parts of the forest floor. Moreover, these two groups of birds, Woodcock and passerines, show interesting variations from layer to layer as regards the proportion (e.g. percent) of birds. Where the passerines decrease, the proportion of Woodcock increased and vice versa. Something similar applies to the relationship between Woodcock and the Galliformes excluding grouse, but not so pronounced. The problem and the material are hardly suitable for statistical inferences, but it nevertheless seems reasonable to believe that these variations can have been caused by changes in climate and environment. True enough it has long been known that conditions in western Norway changed in the course of Sub-boreal period, and vegetational-historically it has been divided into three periods (Kaland 1971). The first part (relatively short) was characterized by a marked expansion of broad-leaved trees. Then there followed a stable middle period (the stage of climax). Towards the end of the Sub-boreal the pine advanced strongly at the expense of some of the broad-leaved trees.

At the end of Sub-boreal time a deforestation of western Norway began. The material from Dollsteinhola seems to reflect these changed conditions in Sub-boreal time. The material from layers 4 and 5 probably belongs to the middle to this epoch. This part of the material shows great diversity of species, especially of birds, a characteristic feature of a climax community. Here and in the deeper layers we mainly find bones of species of the broad-leaved forest such as Hawfinch and Jay *Garrulus glandarius,* and of species which mostly feed on buds and seeds of broad-leaved trees, such as Hazel Hen and Bullfinch *Pyrrhula pyrrhula.* The greater part of the few bones of Capercaillie, more than any other a bird of the pine forests, originates from the upper layers and therefore the final part of Sub-boreal time. In the luxuriant environment on Sandsøya the House Sparrow *Passer domesticus* has found its niche. Some regard this as a good indicator of human activity, while others see it as an attribute of the horse (Broch 1939). Bones of the Wild Horse

Equus caballus have never been found in Norway, and the House Sparrow clearly reached Sandsøya long before the tame horse came to the country. About 3500 years ago Sandsøya was struck by deforestation, and the Polecat and many bird species were no longer able to survive in the coastal area. The cultural deposits in Dollsteinhola give a clear indication that conditions around the cave changed rapidly. The depositing of material has obviously decreased quickly. Probably none of the material is more recent than Subboreal time, and deposits from the last 3000 years are relatively sparse, if one ignores the excrement of domestic animals from more recent times.

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