The First Seal Hunter Families on Gotland

On the Mesolithic Occupation in the Stora Förvar Cave

Christian Lindqvist & Göran Possnert

The article presents some results of a joint interdisciplinary research project, *The Stora Förvar Cave and Gotland's peopling, faunal history and subsistence economy/diet development from the Boreal to the Subatlantic*, initiated by Christian Lindqvist in 1991. Its objectives include investigations of a number of crucial issues in a long-term perspective, such as the initial settlement, the early faunal history, the early subsistence economy and diet, but also the character of the Mesolithic-Neolithic shift on Gotland, by means of human and zoo-osteological, carbon isotope and ancient DNA analyses. The article presents and discusses artefact, osteological, and ^{13}C and ^{14}C data and interpretations concerning the duration and character of the Mesolithic occupation – temporary kill/butchering site, seasonal hunting station, semi-sedentary base camp or burial cave – as well as osteobiographical data on the identified human individuals and their burial customs.

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INTRODUCTION

The Stora Förvar Cave is situated 21.3 m.a.s.l. (at the cave mouth) on the northern part of the island of Stora Karlsö, ca. 8 km to the west of Gotland in the Central Baltic Sea (figs. 1-2). The first hunters, according to AMS-dates on bone collagen, arrived on the island of Stora Karlsö about 7,200 cal. BC at the latest. It is probable that they came along the south-east Swedish coast via the Baltic island of Öland and across the *Ancylus Lake* to Stora Karlsö, where the distance was shortest, although there are of course other possibilities. The distance from the Swedish mainland to Gotland is a good 80 km. The distance from the east Baltic coast is ca. 140-150 km and from the south Baltic coast ca. 225-230 km. Since the early Mesolithic material culture on Gotland – perhaps due to the importance of marine hunting – especially concerning the flint and bone/antler artefacts, is fairly unsophisticated compared to its mainland counterparts, it is not possible to connect it with any particular source area on

Excavation spit	Approximate level below surface	Archaeological period
G.1-2	0-0.6 m	Recent sheep guano/ sterile
GH.3	0.6-0.9 m	Iron Age
G.4	0.9-1.2 m	(Middle Neolithic-) Late Neolithic- Bronze Age
G.5	1.2-1.5 m	Middle Neolithic
G.6	1.5-1.8 m	Middle Neolithic
G.7	1.8-2.1 m	(Late Mesolithic) /Early Neolithic-Middle Neolithic
G.8	2.1-2.4 m	Early Mesolithic/ (Late Mesolithic)
G.9	2.4-2.7 m	Early Mesolithic
G.10	2.7-3.0 m	Early Mesolithic
G.11	3.0-3.3 m	Early Mesolithic
Base	3.3 m	Cave floor

Table 1. A generalized scheme of the excavation spit and cultural layer sequence in area G in the Stora Förvar Cave on the island of Stora Karlsö.

the mainland, where the material culture was adapted to terrestrial large game hunting, for example of aurochs, elk, red deer, roe deer and wild boar.

The Stora Förvar Cave was excavated by Lars Kolmodin and Hjalmar Stolpe in 1888-93. In spite of its importance (the very well-preserved faunal and human remains, the long layer sequence, etc.) the material has to a large extent not yet been analysed and published. During the last seven years, one of the authors (CL) has analysed the faunal and human remains from one of the excavation areas (parcelle G, with a 3.3 m deep deposit excavated in 30 cm spits, see figs. 3-4, tab. 1), together with faunal remains from ten other Mesolithic dwelling sites as well as some Neolithic materials from main Gotland.

The cultural layer in the inner part of the cave seems largely to have been composed of ashes, probably due to the continuous existence of a large hearth, which is clearly visible in a photo taken over a century ago by one of the excavators, Hjalmar Stolpe (fig. 4). Although fire-damaged bones are generally uncommon finds, fairly numerous burnt bones are found in parcelle G, level 8 (G.8), that is, just below the Neolithic cultural layer beginning in G.7. Among these burnt bones are also found charcoal and some charred hazelnut shells. A hazelnut shell from G.8 has been AMS-dated to 7795 ±105 BP (Ua-2937), 6,696–6,465 cal. BC (1 σ). Since there are cut-marks on several of the seal bones and since numerous flints were found in the ashy cultural layer, the skins, meat and fat were probably processed beside a hearth in the cave. This activity was most intensive during a few hundred years, ca. 7,300-7,000 cal. BC, and interrupted less than a millennium later, about 6,200 cal. BC, perhaps due to the flooding of shore terrasses up to 18-20.5 m.a.s.l. by the first *Litorina* transgressions. The same thing seems to have occurred at Visborgs Kungsladugård in Visby country parish (Lindqvist 1997c:102, fig. 6). On this occasion three known shore-bound dwelling sites on main Gotland, Strå kalkbrott in Bunge parish, Gisslause in Lärbro parish and Svalings in Gothem parish, were flooded and covered with *Litorina* shore gravel (fig. 1). This could have had a negative effect on the grey seal rookeries on the island of Stora Karlsö and on the Gotland coast, and in combination with the intensive hunting of young seals – there were perhaps about a thousand seals deposited in the Mesolithic layer in the Stora Förvar Cave – it could have caused a decline in the grey seal population (Pira 1926:130-131; Clark 1976:114-116;

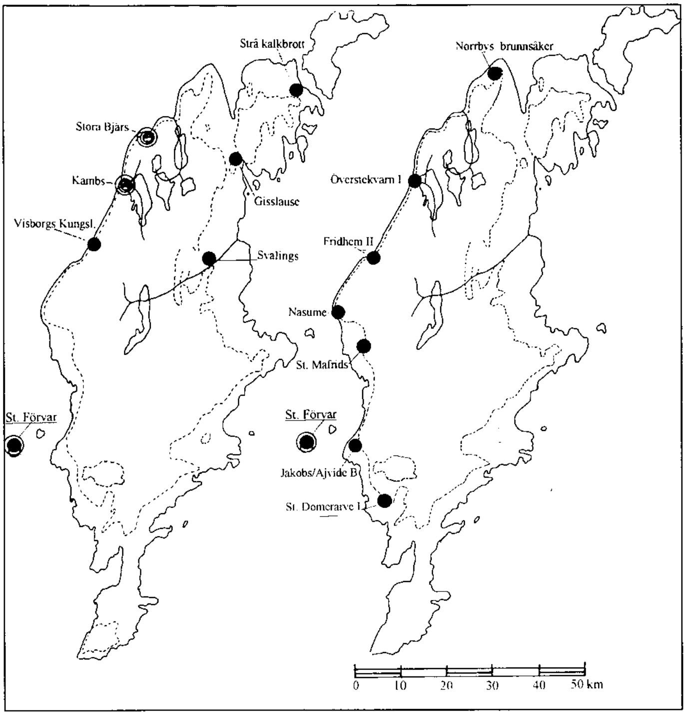
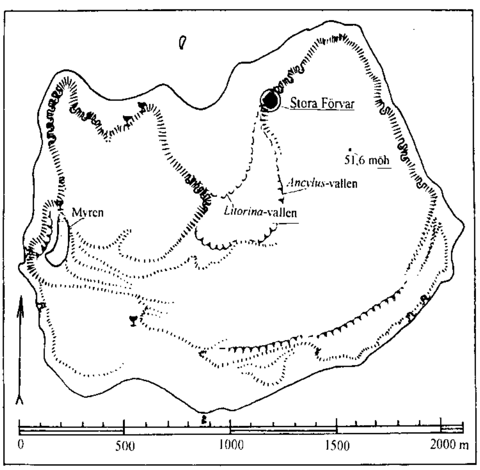


Fig. 1.a-b. The location of the Mesolithic sites mentioned in the text. The earlier Mesolithic dwelling and burial sites (left map) and the later Mesolithic dwelling sites (right map). These sites have yielded preserved faunal and/or human osteological remains.



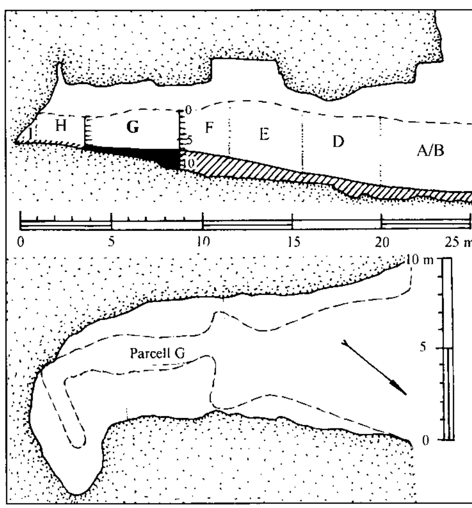


Fig. 2. (left) The island of Stora Karlsö with the location of the Stora Förvar Cave. Other caves in the klint and the raised beaches of the Ancylus Lake and the Litorina Sea are marked, as is a freshwater fen ('Myren') and three other freshwater wells.

Fig. 3. a-b. (right) a. Section drawing through the Stora Förvar Cave in eastern view (after Stenberger in Schnittger & Rydh 1940:62 fig.23) (top). The excavation areas (A/B-I) and the approximate extension of the preceramic Mesolithic layer (black and hatched) are marked. b. Plan over the cave (after Schnittger & Rydh 1940:21 fig.11) (bottom). The broken lines in both drawings show the surface of the cultural layer at the beginning of the excavation. The vertical scales delimiting the G area show the excavation levels, comprising 30 cm each.

Fig. 4. The section of the 3.3 m deep cultural layer between parcelles G and F during the excavation in 1891-92 of the Stora Förvar Cave. The lower third is composed of preceramic (Mesolithic) levels (G.11-8). Ash lenses and ash horizons, and the ash of a hearth a little to the left of the middle, are clearly seen. The stratigraphy does not seem to be disturbed by burials. In the foreground, finds in the base level of the F area seem to be marked with sticks. Large roof-fall rocks made the excavation difficult. Photo: Hjalmar Stolpe, 1891-92.

Hildebrandt & Jones 1992:388-389; Jones & Hildebrandt 1995:78-90; Lyman 1995:46-47; Lindqvist 1997c:101-102, fig. 6).

It is significant that so few terrestrial species are represented in the faunal remains from the Mesolithic dwelling sites on Gotland, that the meals seem to have been composed to 99% of marine foodstuffs. The Mesolithic (and Neolithic) subsistence economy, seasonality and faunal history of Gotland have recently been summarized elsewhere (Lindqvist & Possnert 1997c:35, 39-44, 51-64, 73-76, 79-81; Lindqvist & Storå 1997:22-23). The grey seal cubs were apparently mainly hunted during the winter or spring, but the ringed seals were hunted during the late summer and autumn. The salmons were caught during the summer half of the year. Migrating aquatic birds and hares were mainly caught during the autumn/winter and spring. Initially mountain hare (*Lepus timidus*) was present on the islands of Stora Karlsö and Gotland, and later red fox (*Vulpes vulpes*) appeared. These species may have crossed the sea on fairly thin winter ice. The presence of dog, hedgehog or field mouse has not been proved during this earlier Mesolithic period on Gotland, but they appear later during the final Mesolithic or Neolithic periods. This is due to the fact that Gotland is a zoogeographically isolated island in the central Baltic Sea, and quadruped terrestrial animals may only have crossed the Baltic Sea on winter ice, on floating tree trunks, or were unintentionally transported by man in canoes, rafts, etc. The access to boats or large canoes, which are depicted on the hunters' Stone Age rock engravings along the North Fennoscandian coasts (Lindqvist 1983:3-6, 1984:24-27, 1994), was naturally a prerequisite for the human settlement of Gotland, as well as for a successful sea mammal exploitation and fishing during a period with a milder climate than today. During the earliest period of occupation, according to the animal bone material from levels G.11-8 in the Stora Förvar Cave, there apparently was a breeding colony of hundreds of grey seals (*Halichoerus grypus*) on the island of Stora Karlsö. The climate during the postglacial climatic optimum late Boreal and early Atlantic periods was warm, and the mild winter ice conditions seem to have favoured the grey seal, which fairly recently may have immigrated from the north Atlantic Ocean. It may have immigrated into the *Yoldia* Sea across the Närke Strait in Middle Sweden, and then established a population that became isolated in the *Ancylus Lake*. The warm climate is also indicated by the rare occurrence of the ringed seal (*Phoca (Pusa) hispida*), which demands firm ice during the breeding season (Lindqvist & Possnert 1997c:39-44, 51-64). The early occurrence of water chestnut (*Trapa natans*)

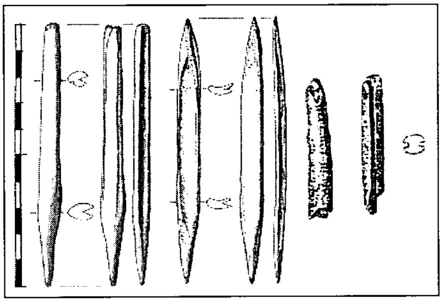


Fig. 5. The two slotted bone points from G.7 and G.6 in the Stora Förvar Cave. (Drawings by CL). The Stora Bjärs slotted bone point is shown for comparison. (After Arwidsson 1979:21 Fig. 4; without scale)

pollen in a core from Mästermyr on Gotland (Persson 1978:29, fig. 23), may also be interpreted in this direction.

In spite of the access to the large seal resource, it is a little mysterious that people chose to settle on Gotland, which lacked other terrestrial game than hare. They probably were quite surprised when they realized that this large island – in spite of a lush vegetation and plenty of fresh water – entirely lacked large terrestrial game. The almost total lack on Gotland (except possibly in the Stora Bjärs grave in Stenkyrka parish) of formal geometric microlithic tools and microblade cores, which are typical forms in the material culture on the mainland, is probably due to this lack of large terrestrial game on Gotland and the island of Stora Karlsö. The two so-called bird arrowheads, that is slotted bone points, a typical artefact in the Maglemosian technocomplex during the late Boreal and early Atlantic zone on the mainland (Lidén 1942; Welinder 1971), from G.7-6 in the Stora Förvar Cave (Rydh 1931:28, fig. 9; Schnittger & Rydh 1940:65, Pl.I:1) and one from the Stora Bjärs grave (Arwidsson 1979:21 fig. 4) (fig. 5), which all lack adhering flint edges, are made of terrestrial animal extremity bones and were apparently imported from the mainland.

The flints found in the Mesolithic levels in the Stora Förvar Cave, which mainly comprise blades (and flakes) chipped out of local ordovician flint pebbles, include several 'conical' platform cores and small splinters, some scrapers and occasional borers, indicating a local manufacture and use of blades and flakes for skinning and butchering purposes inside the cave. Flints and rare bone tools can also be found among the animal bones (fig. 6).

Was the purpose of the occupation simply to extract the seal skins, and was the Stora Förvar Cave merely the butchering place and midden for seal carcasses of a hunting station (Knape & Ericson 1988:33-35 fig. 2; Ericson & Knape 1991:201-202), where the seals were killed by small bands of adult male hunters who perhaps travelled the 80 km from the mainland to stay only during limited seasons? Or did whole families of marine-adapted semi-sedentary hunters live in the cave for longer periods, extracting seal meat and blubber, fishing and catching birds, gathering hazelnuts and other plant food, tending fires for heating and cooking, chipping flints, chipping and grinding stone axes, making bone and wooden tools, scraping hides and building boats?

Due to the identification of a 4-6 month old infant, two ca. 10-14 year old youngsters,

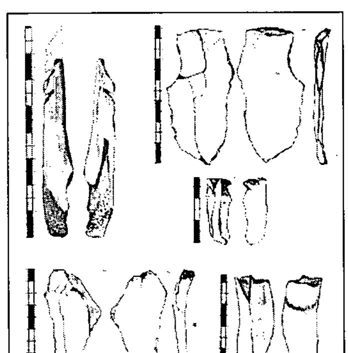


Fig. 6. Mesolithic flint blades and a toothed bone point found mixed with the faunal material from the Stora Förvar Cave during the 1990s. (Drawings by CL)

one of them a girl, a 14-21 year old young man, at least one young woman and two young men, an adult/mature woman, at least one adult man, it is not likely that the cultural layer in the Stora Förvar Cave has been deposited during temporary visits to a seasonal hunting camp. A more permanent occupation is also indicated by the 1.2 m deep Mesolithic cultural layer consisting of ash and containing enormous amounts of seal, bird and fish bones, that point to plentiful resources the year round. The layer also contains numerous flint blades, flakes, some conical platform cores and stone axes, indicating tool making in the cave.

THE HUMAN BONE MATERIAL

Early finds

During the excavation of the Stora Förvar Cave, two human crania and postcranial bones were found in 1890 at a depth of 3-3.5 m in excavation area D about 7-8 m inside the entrance of the cave. The crania were said to possess sloping foreheads, robust superciliary arches and nuchal crests, and the excavators seem initially to have associated them with the Neanderthal skulls found in 1856 in the Feldhofer Cave near Düsseldorf in Neanderthal, Germany and in 1886 in the Spy Cave, Namur, Belgium (Boule & Vallois 1957:196, 198-199; Gore 1994:8-9; Stringer & Gamble 1994:13-14).

The crania and extremity bones showed remarkable traces of work (cut-marks and splitting), that were interpreted as signs of (butchering and) marrow-extraction and hence cannibalism. Although Gustav Retzius, in a lecture addressed to the Swedish Society for Anthropology and Geography in November 21 1890, noted that the skulls were not of the same primitive type as the Neanderthals, he interpreted the marks as signs of cannibalism (Retzius 1890; Rydh 1931:23, 41-42; Schnittger & Rydh 1940:38-39, 42, 46-48). Unfortunately, the two crania seem later to have disappeared. Carl Fürst wrote about the remarkable marks on the human bones in letters dated 1912 and 1925, but it is unclear whether he had access to the skulls or not.

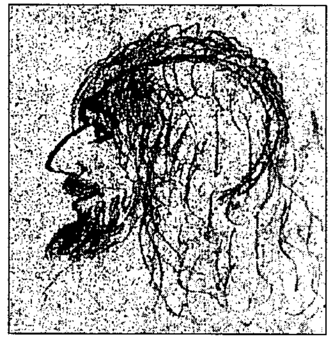


Fig. 7. A drawing titled 'A Carlsö-aristocrat 3000 years ago' found in Lars Kolmodin's file at the Antiquarian Topographical Archive (ATA), the Central Board of National Antiquities, Stockholm. (Unknown artist)

A drawing found in Lars Kolmodin's file in ATA can perhaps mediate the spirit of the times more than a century ago among the excavators on the island of Stora Karlsö in particular and among Swedish archaeologists and anthropologists in general. The drawing is humorously titled *'A Carlsö-aristocrat 3000 years ago'*, and the artist may have used a known person at the excavation on Stora Karlsö as a model for this caricature. Although the nose and chin are 'aristocratic', the forehead is low and sloping and the superciliary arch is protruding (fig. 7).

The lost crania from the Stora Förvar Cave were intensively searched for, but in vain. On June 28 1930, Axel Bagge stated that the importance of the Stora Förvar skulls was to a large extent exaggerated, and that the information needed about the earliest humans on the Baltic shores could just as well be supplied by other Swedish Stone Age human crania, that is, from megalithic graves in Västergötland. This was, as we shall see, a misinterpretation. In fact, the earliest Stora Förvar Cave humans are not only earlier in date than the megalithic tombs, but also earlier than the Bäckaskog burial in Scania

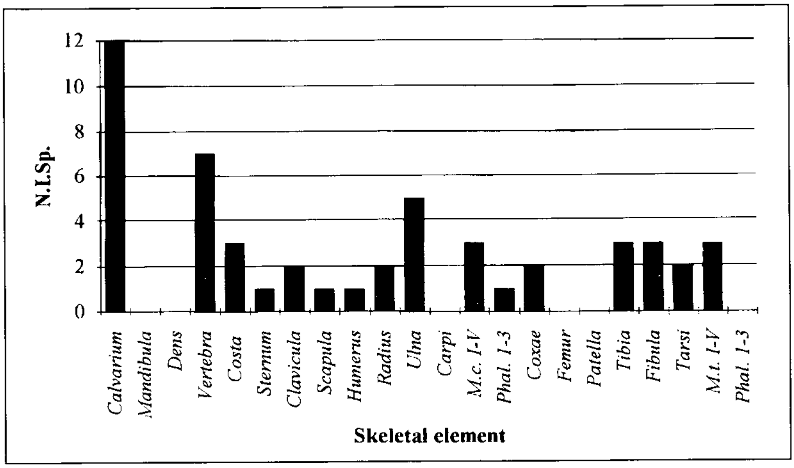


Fig. 8. The abundance of Mesolithic human bones per skeletal element in area G in the Stora Förvar Cave on the island of Stora Karlsö, Eksta parish, Gotland. A total of fifty human bones were identified from the original preserved material excavated by Lars Kolmodin and Hjalmar Stolpe in 1888-93 in the preceramic levels (G.11-8) of the cave. Almost all skeletal elements are represented. However, the fifty human bones comprise less than 1% (ca. 0.3% or 3‰) of the almost 16,000 seal bones in the Mesolithic levels in area G. (NISp.= No. of Identified Specimens.)

found in 1939 (Hanson 1941; Althin 1950; Munthe 1954; Gejvall 1970; Welinder 1971), the two or three Kambs burials found in 1939 and 1947 (Arwidsson 1949; Gejvall 1949; Larsson 1982) and the Stora Bjärs burial found in 1953 (Munthe 1954; Arwidsson 1979; Gejvall 1979; Larsson 1982) on Gotland.

Recent finds

When analysing the excavation material from parcelle G, several new human bones were identified that might shed light on the character of the earliest occupation. This material is accounted for in the diagram above (fig. 8), and more in detail in the following text and figures (figs. 9-16).

The Stora Förvar Cave children

INDIVIDUAL NO. 1. Very interesting are the finds of ten bones, mainly extremity bones (1 *Costa*, 1 *Scapula dx.*, 1 *Humerus dx.*, 2 *Radii*, 2 *Ulnae*, 2 *Tibiae*, 1 *Fibula sin.*) (fig. 9), of an infant from G.10 in the Stora Förvar Cave among enormous amounts of seal bones from the Mesolithic cultural layer. The living age estimation implies the first part of the *infans I* interval. Based on the length of the extremity bones, the living age may be more specifically estimated to 4-5 (up to 6) months, implying that this was in fact a suckling baby (after comparisons with reference material in Johnston 1962; Stloukal & Hanáková 1978; Hoffman 1979. See fig. 10a-e). The body length of the infant is estimated to ca. 65-70 cm (after Kósa 1989).

In the diagrams (fig. 10a-e) the bone lengths of the Stora Förvar Cave infant are plotted against a presumed living age of 4 months and compared to the length of extremity bones of known living age. Since the age according to comparisons with Medieval Czech children is estimated to be between 4 and 6 months (after Stloukal & Hanáková 1978), and since this approximation corresponds well with the age and extremity length of recent North American children (after Hoffman 1978), the true living age is probably to be found in this interval.

This individual is AMS ^{14}C-dated on bone

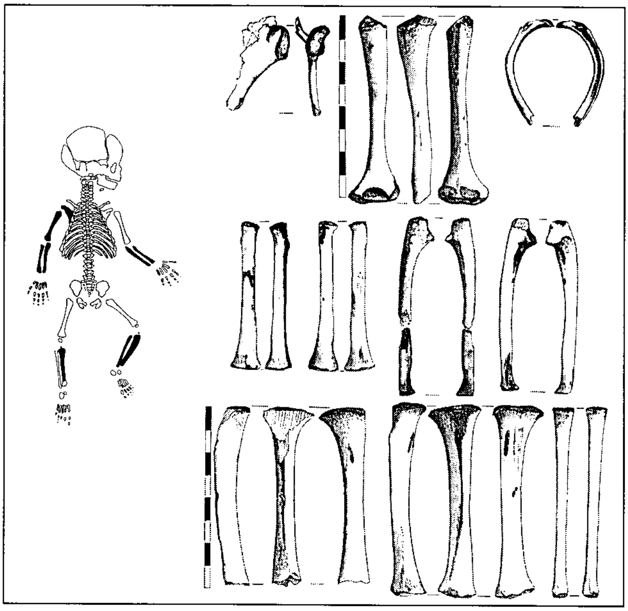


Fig. 9. Very interesting are the finds of ten, mainly extremity, bones of an infant (individual no. 1), all from G.10 in the Stora Förvar Cave. The living age of this infant is estimated to 4-6 months, i.e. it was a suckling baby, and the 'stature' is estimated to about 65-70 cm. According to a ^{14}C-dated lower arm bone, this child belonged to the earliest inhabitants of the cave. (Drawings by CL. The bones are marked in black in their respective anatomical positions in the skeleton to the left.) (Scale in cm)

collagen to 7,256-7,004 cal. BC, after the subtraction of 100 years due to the reservoir effect (tab. 2).

Conclusions concerning the cause of death cannot be reached through the morphology of the baby's bones, which look healthy, but when they have been thoroughly analysed concerning their chemical content it may be possible to say whether the baby perhaps died from malnutrition.

The δ^{13}C-value, –18.0‰ vs PDB, of the Stora Förvar infants bone collagen is about 1‰ more marine than the adult individuals (tab. 2), which may be explained by accumulation during the suckling. Provided the mother consumed a lot of grey seal liver or salmon meat, this might have caused hypervitaminosis A or D in the suckling infant.

Women of some marine-adapted groups known in historical times, e.g. the Northwest Coast Indians, seem to have avoided too much sea mammal and salmon meat during pregnancy and lactation, and instead concentrated on gathered terrestrial animal and plant food, since it seems to have been known that small children are sensitive to, and indeed may die from, *hypervitaminosis*, i.e. overconsumption of e.g. (A- or) D-vitamin from e.g. (carnivore liver and) salmon meat (Lazenby & McCormack 1985 via Klepinger 1992:125). Too much animal protein in the diet may also result in *osteoporosis*, which is known among Inuits (Thompson *et al.* 1983; Beall 1987 via Klepinger 1992:125).

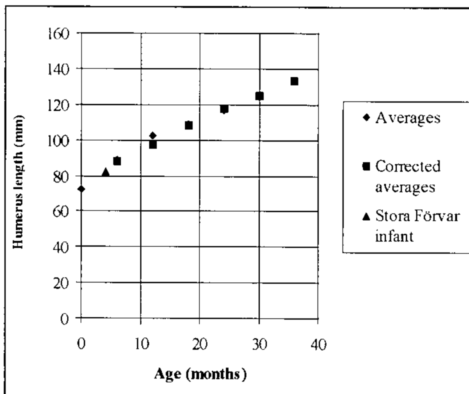


Fig. 10.a. The living age of the infant, individual no. 1, from G.10 in the Stora Förvar Cave according to Humerus *length (mm) seems to correspond to about 4 months. (Averages and corrected averages according to reference material in Milan Stloukal & Hanáková 1978:53-69, Tab.4).*

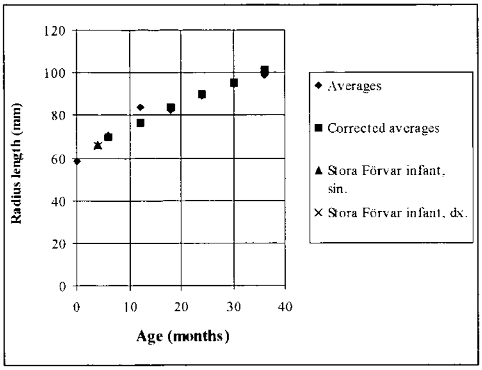


Fig. 10.b. The living age of the infant, individual no. 1, according to Radius *length (mm) seems to correspond to about 4 months. (After Stloukal & Hanáková 1978:59, Tab.5).*

Fig. 10.c. The living age of the infant, individual no. 1, according to Ulna *length seems to correspond to about 6 months. (After Stloukal & Hanáková 1978:59, Tab.6).*

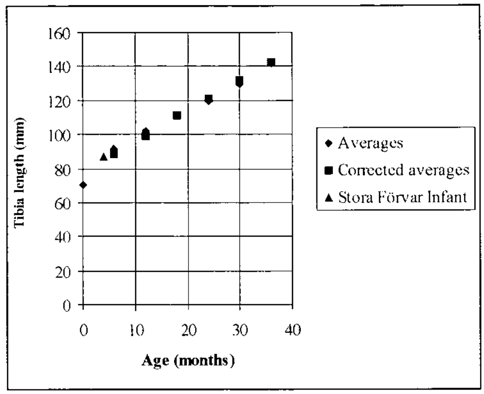


Fig. 10.d. The living age of the infant, individual no. 1, according to Tibia *length (mm) seems to correspond to about 5 months. (After Stloukal & Hanáková 1978:60, Tab.8).*

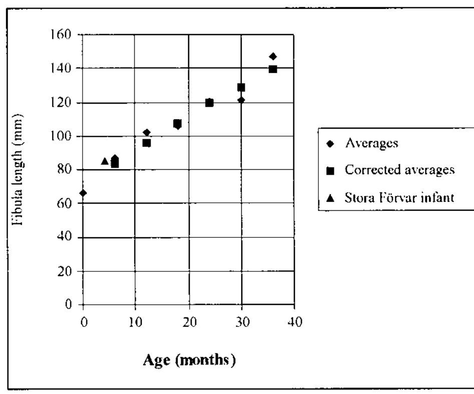


Fig. 10.e. The living age of the infant, individual no. 1, according to Fibula *length (mm) seems to correspond to about 6 months. (After Stloukal & Hanáková 1978:61, Tab.9).*

The early Mesolithic settlement on Gotland in the central Baltic may not have had any previous experience of such *hypervitaminosis* (A or) D, since they obviously had only recently moved from the mainland, where terrestrial herbivore meat predominated in the diet. Hence, they may not yet have known how to cope with this kind of malnutrition, or rather nutritional excess.

The malnutrition/nutritional excess hypothesis is supported by the fact that the bone collagen $\delta^{13}C$-value of the baby is higher than the adults', instead of *vice versa* as among the Northwest Coast Indians (Chisholm *et al.* 1983) for which Lazenby and McCormack hypothesized an age-specific dietary specialization, as well as among pregnant and lactating women, in response to the previous effect of *hypervitaminosis* D caused by high salmon consumption (Lazenby & McCormack 1985). The bone samples of the following individuals all have ca. 1‰ higher $\delta^{13}C$ values than the contemporaneous seal bones, which is in agreement with a diet mainly composed of seal products.

INDIVIDUALS NO. 2 AND 3. Also interesting are three thin, gracile cranial fragments (2 *Frontale*, sin. and dx., 1 *Parietale* sin.) (fig. 11) from G.10 and G.8 in the Stora Förvar Cave, which are from two children just before the teenages, one of them probably a girl. The living age estimation based on bone thickness and morphology corresponds to the later part of the *Infans II* interval or the transition between the *Infans II* and *Juvenilis* intervals, i.e. 10-14 years. To judge from the sharp edge of *margo supraorbitalis*, the frontal bones may belong to a girl. These individuals has only recently been AMS ^{14}C-dated on bone collagen from a parietal bone (individual no. **2**) to 7,293-7,032 cal. BC (δ^{13}C:-18.4‰ vs PDB) and from a frontal bone (individual no. **3**) to 6,603-6,453 cal BC (δ^{13}C:-17.7‰ vs PDB) (tab. 2).

The average of 24 measurements of the two gracile frontal bone fragments is only 1.88 mm (0.82-3.08 mm), and the average of 13 measurements of the fairly thin parietal fragment is 2.72 mm (1.76-3.67 mm). Hence, there is a 0.84 mm cross-section difference, which may indicate a slight difference in living age. The sphaenofrontal sutures in both frontal bone fragments are of course entirely unobliterated. The frontal bones are very well preserved and have a more yellowish colour, and the parietal bone is slightly more eroded and has a more whitish colour. These small but noticeable differences seem to indicate that the frontal bones and the parietal bone derive from two different individuals, which is further supported by the 430 year difference in ^{14}C-date and the 0.7‰ difference in δ^{13}C value.

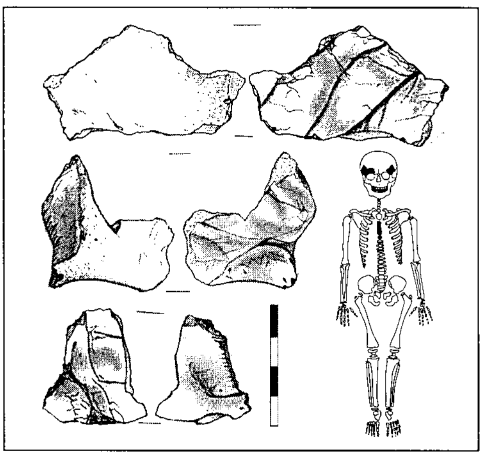


Fig. 11. Also interesting are three thin gracile cranial fragments from G.10 and G.8 in the Stora Förvar Cave, that seem to represent two individuals (individual 2 and 3) just before the teenages, 10-14 years old. One of them was probably a girl, which according to a ^{14}C-dating lived during a later part of the early occupation, whereas the other belonged to the earliest inhabitants of the cave. (Drawings by CL. The frontal bones are marked in black in their respective anatomical positions in the skeleton to the right.) (Scale in cm)

The Stora Förvar Adolescents

INDIVIDUAL NO. 4. A number of bones from a foot (*Calcaneus sin., Cuneiforme intermedium (II), Metatarsus I dx., M.t. IV dx., M.t. V dx.*), a lower leg (distal *Tibia dx., Fibula dx.* with loose epiphyses) etc. (fig. 12) are from a male in the *Juvenilis* interval (10-21 years), or more exactly the upper teenages, ca. 14-21 years old (based on bone fusion sequences after Warwick & Williams 1973; Szilvássy 1988; Bass 1987; Ubelaker 1989; Sorg, Andrews & Iscan 1989). That it concerns a young male is indicated by the partly loose epiphyses and the robustness of the bones. It is also confirmed by a juvenile *Coxae, pubis sin.* of male type. The above is apparently also confirmed by three unfused sacral vertebrae (*Vertebrae sacrale*). Two right and left 'unfused' and unburnt zygomatic bones (*Zygomaticum*) from G.10 and G.8 (left bone: fig. 16a), probably belonging to the same individual, (and possibly an unburnt right frontal bone fragment with unobliterated *sutura* coronalis described under individual no. 5, fig. 15a), seem according to virtually identical AMS-dates and δ^{13}C-values recently conducted also belong to this individual. The 'unfused' frontal processes of these zygomatic bones do not fit together with

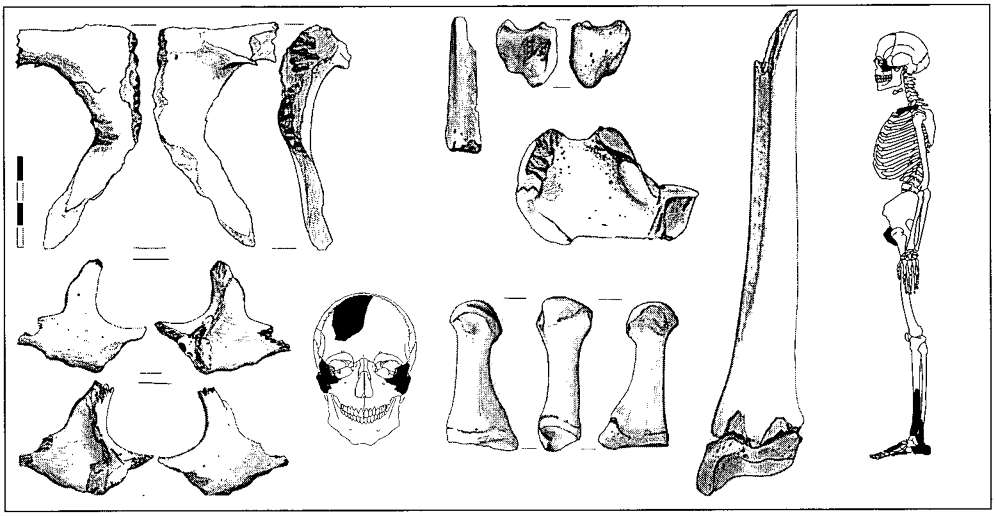


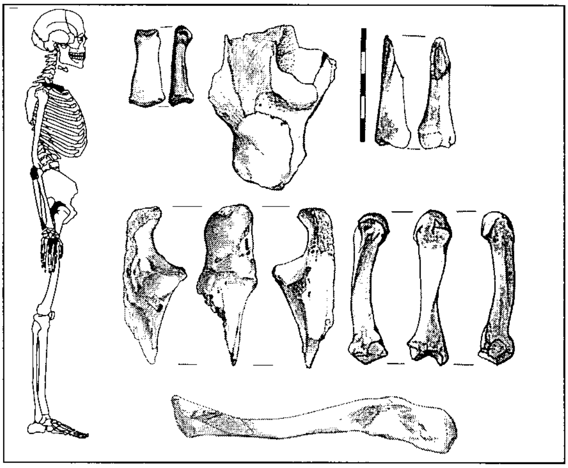
Fig. 12. The earliest human ^{14}C datings from Gotland, almost 7,500 years cal. BC, are associated with a number of lower leg and foot, and probably cranium and pelvis, bones of a young man in the later teenages, 14-21 years (individual no. 4), from the levels G.11-10 and G.8 in the Stora Förvar Cave. The living age of this young man was probably about 18 years, and the stature is estimated to about 174 cm. (Drawings by CL. The bones are marked in black in their respective anatomical positions in the skeleton to the right and the cranium in the middle, although the clavicle and frontal may belong to other individuals.) (Scale in cm)

the 'unfused' zygomatic processes of the unburnt frontal bones of individual no. 3 (fig. 11) or the burnt frontal bone of individual no. 6 (fig. 14a). These zygomatic bones are also relatively smaller and more gracile than the very robust zygomatic bone of individual no. 10 (fig. 16b).

The stature of the juvenile male may, based on lengths of a heel bone (*Calcaneus* length: 84.67 mm) and first metatarsal (*Mt I* length: 63.74 mm), be approximated to 174 ±6 cm (after comparisons with reference materials in Holland 1995; Byers, Akoshima & Curran 1989). This individual is AMS ^{14}C-dated on bone collagen to 7,567-7,037 cal. BC ($\delta^{13}C$:-18.9- -19.2‰ vs PDB) (tab. 2). When the recently conducted AMS-datings and ^{13}C-analyses on cranial bones and further osteological analysis are included, there seem to be totally two to four adolescents/young adults represented in the Mesolithic cultural layer in parcelle G. Of these at least two are males.

Individual no. 5? An unburnt frontal bone fragment (*Frontale dx.*) from G.9 of medium thickness (cross-section: 1.83-5.25 mm; average of 18 measurements: 3.91 mm), with unobliterated *sutura* coronalis, apparently represents a young adult of unknown sex, but possibly a male. Had this individual been older than 30 years, the ecto- and/or endo-cranial suture obliteration had probably begun, and the living age may according to the lack of suture closure possibly be approximated to the 18-29 years interval (Buikstra & Ubelaker 1994:33-38 fig. 12a; Masset 1989:93, Tab. 4.4). (fig. 15a). This bone has recently been AMS ^{14}C-dated on bone collagen to 7,499-7,307 cal BC ($\delta^{13}C$:-18.1‰ vs PDB) (tab. 2). Due to the virtual identity in date, there is a possibility that the unburnt frontal bone belongs to individual no. 4, although the ^{13}C-value is 0.8-1.1‰ higher, and the living age seem to have been slightly higher than in individual no. 4. This unburnt right frontal bone fragment also seems to

Fig. 13. A number of lower arm and hand bones, associated with a ^{14}C date in the later part of the early occupation, and probably a clavicle and a pelvis-bone fragment, belong to an adult or mature woman (individual no. 8) from the levels G.10 and G.8 in the Stora Förvar Cave. The living age of this adult woman was probably higher than 26-30 years and the stature is estimated to about 160 cm. (Drawings by CL. The bones are marked in black in their respective anatomical positions in the skeleton to the left.) (Scale in cm)



belong to a different individual than the burnt right frontal bone fragments of individual no.6.

INDIVIDUAL NO. 6. A fire-damaged fragmentary right frontal bone (*Frontale dx.*) assembled of three fragments from G.10 and G.8, with the whole external surface covered by cut- and scrape-marks (fig. 14a), may – according to its size (max. length: 91.43 mm) and medium thickness (average cross-section: 4.55 mm [2.76-5.79 mm, n=18]; *arcus superciliaris*: 7.03 mm), its completely unobliterated *sutura coronalis*, its rounded *margo orbitalis* and relatively marked *arcus superciliaris* – derive from a fairly young, male, individual, possibly of about the same or somewhat higher living age as individual no. 4. Had the individual been older than 30 years, the ecto- and/or endocranial suture obliteration had probably begun, and the living age may according to the lack of suture closure possibly be approximated to the 18-29 years interval (Buikstra & Ubelaker 1994:33-38, fig. 12a; Masset 1989:93, tab.4.4). (fig. 12). Two burnt fragmentary occipital bone fragments (*Occipitale*) from G.8 may belong to the same individual. Since these bones are fire-damaged they have not been dated.

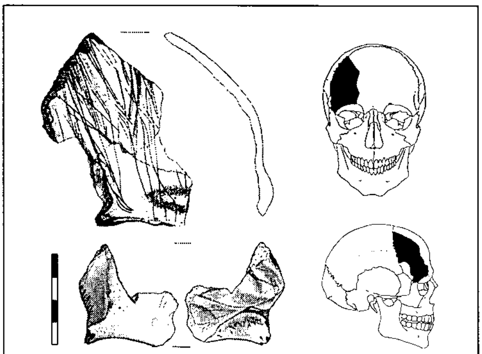


Fig. 14.a-b. Right frontal bones. a. Three assembled fire-damaged bone fragments with cut-marks in anterior view from G.10 and G.8 in the Stora Förvar Cave of a young male in the Juvenilis/ Adultus interval (individual no.6), and cranium with the bone marked in its anatomical position, top; the bone in lateral view (profile), middle; b. Unburnt frontal bone fragment of girl in the Infans II interval (individual no. 3), bottom (for anatomical position, see Fig. 11). (Scale in cm. Drawings by CL.)

INDIVIDUAL NO. 7? A sternally unfused, fairly gracile and short (length: 136.87 mm) clavicle (*Clavicula sin.*) indicates a young woman probably less than 18-23 years and at least younger than 26 years. (Due to the similarity in living age, that is adolescent or young adult, there is a possibility that the bone belongs to one of the juvenile males (individual no. 4, 5? or 6), although this appears less likely, since this clavicle is shorter than the average length of female clavicles.) This bone is fire-damaged and has not been dated.

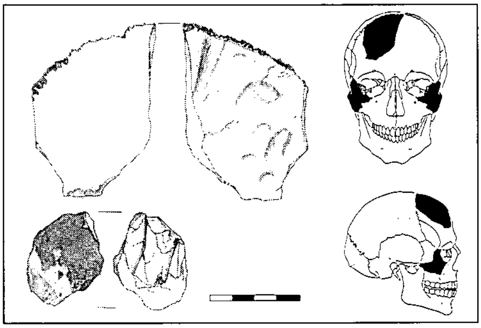


Fig. 15.a-b. Frontal and parietal bone fragments, a. Right frontal bone of a young adult from G.9, dx., in the Stora Förvar Cave (individual no. 5?), ecto- and endocranial view, and cranium with the frontal bone, and zygomatics of individual no. 4, marked in its anatomical position, top; b. Fire-damaged robust parietal bone fragment of an adult male? from G.10 (individual no. 9), bottom. (Scale in cm. Drawings by CL.)

The Stora Förvar Adults

INDIVIDUAL NO. 8. A number of completely fused bones from a hand (*Metacarpus II dx.*, *M.c. III dx.*, *Phalanx 2*) and lower arm (2 *Ulna dx.*) etc. (fig. 13) are from an adult woman (the *adultus* interval, or perhaps in mature age, the *maturus* interval), which is also indicated by a short, but fairly robust, sternally fused clavicle (*Clavicula dx.).* The latter indicates a living age above 26-30 years. A hip-bone fragment (*Coxae dx.)* with completely synostosed *acetabulum* and fused *tuber ossis ischii*, confirms the existence of an adult individual older than 16-21 years. The stature of the adult woman, based on the length of metacarpals (*M.c. II* and *M.c. III*), may be approximated to 160 ±5 cm (after Musgrave & Harneja 1978). This individual is AMS ^{14}C-dated on bone collagen to 6,182-6,003 cal. BC (δ^{13}C:-17.7‰ vs PDB) (tab. 2).

INDIVIDUAL NO. 9. A thick (cross-section: 5.16-7.57 mm; average of 7 measurements: 6.40 mm) robust fire-damaged parietal bone fragment (*Parietale*) from G.10 probably represent an adult male (fig. 15b). This bone

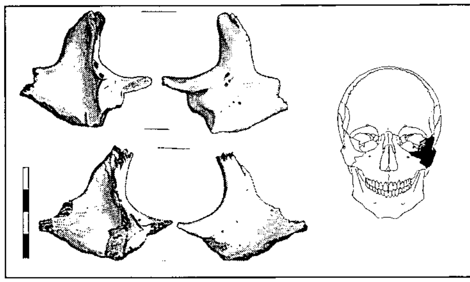


Fig. 16.a-b. Left zygomatic bones. a. Fairly robust complete bone from G.8 in the Stora Förvar Cave (individual no. 4), bottom (for anatomical position, see Fig. 15.a); b. Robust complete bone from G.7 of an adult male associated with a late Mesolithic ^{14}C dating (individual no. 10), and cranium with the bone marked in its anatomical position, top. (Scale in cm. Drawings by CL.)

is much too robust to belong to the same individual as the bones described under individual no. 2-8. Since this bone is fire-damaged it has not been dated.

INDIVIDUAL NO. 10. A markedly robust but 'unfused' left zygomatic bone (*Zygomaticum*) (fig. 16b) from G.7, probably indicating the existence of a young adult male individual, has been AMS ^{14}C-dated to 4,246-3,987 cal. BC (δ^{13}C:-16.25‰ vs PDB) (tab. 2). This is the only hitherto known late Mesolithic human bone from Gotland.

Two recently conducted AMS-dated cranial bones are contemporaneous to individual no. 4, and very close in date to individuals no. 1, 2 and 5. Whereas the bones of individuals no. 2 and 3 are of too young individuals, which also have different δ^{13}C values, there is a possibility that the dated frontal and especially the zygomatic bone may derive from individual no. 4, although the latter individual is probably also too young, especially compared to the frontal bone. This is supported by the similarity in ^{14}C dates and δ^{13}C values between individual no. 4 and the zygomatic, and the dissimilarity in δ^{13}C values, with a 0.8-1.1‰ difference, between individual no. 4 and the frontal bone, which probably represents a separate individual

(individual no. 5?).

Additionally there are a number of *Vertebrae* and *Costae*, apparently belonging to various individuals, some of them mature. Three sacral vertebrae probably belong to individual no. 3.

Hence, there are at least four hitherto dated individuals from the ca. 8,300-8,200 BP (c. 7,500-7,000 cal BC) interval, and three dated individuals later than 7,900 BP in the Mesolithic levels from the cave and one from G.7. Including the undated fire-damaged cranial bones, and the fire-damaged clavicle, totally 9 or 10 individuals are represented. Of the cranial bones only a couple are robust enough to stem from adult men; most of them seem to stem from young individuals.

ON THE STORA FÖRVAR CHRONOLOGY AND STRATIGRAPHY

Several earlier scholars have assigned the aceramic lower levels in the Stora Förvar Cave to the Vrå/Säter II period, which was apprehended as corresponding to the period of the so-called axe dwelling sites, thought to be contemporaneous with the *dolmen* period, approximately 5,000/4,500 BP (Nihlén 1927:65; Rydh 1931:11, 19; Schnittger & Rydh 1940:65, 75, 78-79; Stenberger 1964:96, 102; Clark 1976:115, fig.1; Knape & Ericson 1983:169, 172, 1988:31, 33, 35; Ericson 1989:192-193, 198; Ericson & Knape 1991:198, 202-203). This is, according to our artefact and osteological studies and dating results, obviously a misinterpretation. However, Henric Munthe (1940:197, 225, 1954:697) claimed that the two so-called bird arrowheads, that is slotted bone points of Lidén's type A (Lidén 1942:28-30) from G.7-6, which are typical artefacts for the Maglemosian techno-complex during the late Boreal and early Atlantic zones and the final *Ancylus* and early *Mastogloia* stages (Welinder 1971), were associated with the first occupation in the Stora Förvar Cave and that it occurred already during the *Ancylus Lake* stage. Also Mats Malmer (1962:940) assumed the presence of Mesolithic layers in the cave. In a couple of lectures given at the Dept. of Archaeology, Stockholm University, in 1982 and 1984 one of the authors (CL) claimed that these early levels (G.11-8) must be Mesolithic. This conclusion was based on the almost total lack of pottery finds in the lower levels; that the flints in this preceramic cultural layer were mainly composed of narrow and thin blades apparently pressed from several conical platform cores, whereas there are relatively more wide and thick flakes in the ceramic cultural layer; and that the fauna also differ markedly from the fauna in the ceramic cultural layer. A calculation, based on the assumption that the sedimentation rate had been constant throughout the stratigraphy, and according to which the base level could be dated approximately to 6,000-6,500 BP, was also presented.

Furthermore, in a lecture given by us (CL and GP) at the Department of Archaeology in Stockholm in 1993 (as well as at international conferences, for instance in Esbjerg in 1993 and in Copenhagen 1998), we presented a new chronological interpretation based on a series of AMS ^{14}C dates on human and animal bone collagen from the cave, implying that the levels G.11-8 in fact comprised the earliest known Mesolithic cultural layer on Gotland, and that there was a chronological and stratigraphical *hiatus* between ca. 7,440 and 5,500 BP (See tab. 2 and figs. 17-18).

Since datings on bone collagen of marine-adapted humans are – in this case due to the consumption of grey seal and salmon, and later harp seal, porpoise, cod and herring – more or less affected by the reservoir effect, and as such show an apparently older age than dates conducted on contemporaneous terrestrial material, and since the degree of the reservoir effect on bone material from various Baltic stages in prehistoric time was unknown, we also made datings on mountain hare (*Lepus timidus*) bones found in the same layers as the human bones described above.

Locality	Ind. No.	Skeletal element	Living age	Sex	^{14}C date BP	$\delta^{13}C$ ‰ vs PDB	Lab. No.
St Förvar G.10	4	*Fibula, dx.*	*Juvenilis*	Male	8555 ±135	-19.2	Ua-3132
-"-, G.8	4	*M.t.IV, sin.*	*Juvenil./Ad.*	Male	8340 ±100	-18.9	Ua-3789
-"-, G.11	4	*M.t. I, sin.*	*Juvenil./Ad.*	Male	8270 ±75	-19.2	Ua-2918
-"-, G.10	4	*Zygomatic., dx.*	*Adult?*	Male?	8360 ±95	-18.9	Ua-13554
-"-, G.9	5?	*Frontale, dx.*	*Juvenil./Ad.*	Male?	8380 ±85	-18.1	Ua-13555
-"-, G.10	2	*Parietale, sin.*	*Infans II*	-	8260 ±95	-18.4	Ua-13407
-"-, G.10	1	*Ulna, sin.*	*Infans I*	-	8220 ±95	-18.0	Ua-3788
Kambs	II	*Tibia*	*Adult*	Female	8050 ±75	-18.0	Lu-1983 *
-"-	?	?	?	?	-	-17.9,-19.1	¤
St Bjärs		*Dens M*	*Ad./Matur.*	Male	7970 ±80	-17.8	Ua-10426
St Förvar G.10	3	*Frontale, sin.*	*Infans II*	Female?	7830 ±90	-17.7	Ua-13406
-"-, G.8	8	*M.c. II, dx.*	*Adult*	Female	7440 ±85	-17.7	Ua-2930
-"-, G.7	10	*Zygomatic., sin.*	*Adult*	Male	5500 ±95	-16.3	Ua-3130
Alby	XXV	*Dens*	*Adult*	Male	5260 ±70	-15.4	Ua-2333 #
-"-	-"-	*Os*	*Adult*	Male	5200 ±150		Ua-1713 #

*) Published in Larsson 1982:12-13; ¤) Published in Lidén 1995:VI:9, Tab. 1; #) Published in Königsson *et al.* 1993:32-34, Tab. 1.

Table 2. Uncalibrated AMS (and conventional) radiocarbon dates conducted on Mesolithic human bones from Gotland and the island of Stora Karlsö in an aquatic/marine adapted context. (A late Mesolithic human date from grave 25 at Alby in Hulterstad parish on Öland is included as a comparison to the late Mesolithic human date from G.7 in the Stora Förvar Cave.)

Since the hare as a terrestrial species is unaffected by the reservoir effect, dates on hare bone are more reliable than on bone collagen of seal and marine-adapted man; the latter is apparently influenced by a reservoir effect of about 100 years in contrast to the hare bones during the early Mesolithic on Gotland, and seem to give somewhat earlier datings (fig. 17).

Four calibrated AMS-datings of mountain hare bone collagen from the lower levels (G.11-7) in excavation area G in the Stora Förvar Cave indicate that the first and most intensive occupation and seal exploitation occurred between 8,200 ±125 and 7,715 ±80 BP, i.e. 7,420-6,429 cal. BC (1 σ) (See fig. 17). Hence, the earliest Stora Förvar AMS-dates are – as well as the AMS-dates from Stora Bjärs and Bäckaskog – well within the expected chronological and quaternary geological interval for slotted bone points in general and more specifically for Lidén's type A (Lidén 1942), that is the late Boreal/early Atlantic zones and final *Ancylus*/early *Mastogloia* stages, and generally confirm Munthe's and Althin's, and exactly confirm Welinder's, typological and quaternary geological datings of these finds (Munthe 1940, 1954; Althin 1950, 1951; Welinder 1971).

The $\delta^{13}C$ values in human bone collagen were gradually rising over time, from –19.2/-18.0‰ during the transition between the final *Ancylus* and early *Mastogloia* stages (ca. 8,300-8,200 BP) – when the Öresund Strait opened up and the change according to the diagram initially was fairly abrupt – to a maximum of -16.2/-15.0‰ during the later *Litorina* stages (ca. 4,200-4,000 BP) (fig. 18). This apparently reflects the gradually rising salinity and the mixture between the fresh, 'young' water from the Baltic rivers, containing much atmospheric carbon, and the saline, 'old' water from the Atlantic Ocean, where the carbon had already decayed during some time, within the Baltic Basin (Lindqvist & Possnert 1997a:73-74, 1997c:51-64). The

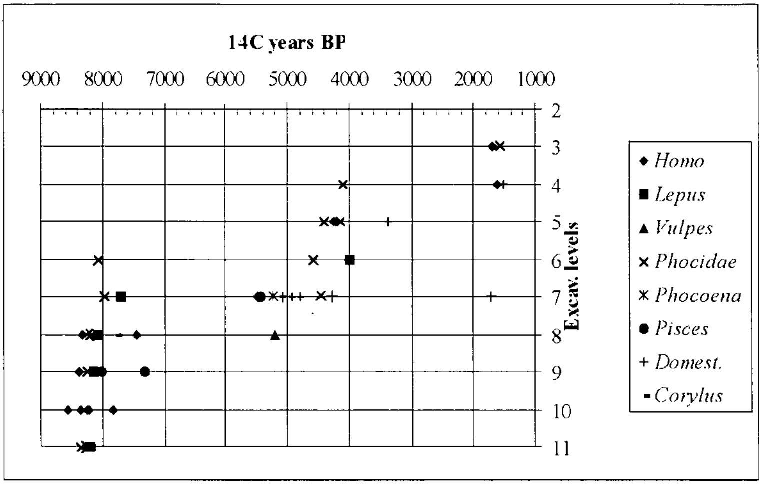


Fig. 17. Uncalibrated AMS-datings on human and animal bone collagen (and a hazelnut shell) from the various excavation levels (11 to 3) in excavation area G in the Stora Förvar Cave. Observe the chronological and stratigraphical hiatus *between ca. 7,400-7,300 (in level G.8-9) and ca. 5,500-5,200 BP (in level G.8-7). (Domestic animal bone dates from the Mesolithic levels are excluded. They are, as expected, intrusive.)*

δ^{13}C values, ca. -19–21‰ after 5,000 BP, definitely indicate a terrestrial diet, probably mainly based on introduced domestic animals, a diet that during a limited period was changed back to marine adaptation during the late Middle Neolithic (Lindqvist & Possnert 1997b:152-153, 1997c:55-58, tab. 17, fig. 5; 60-62, fig. 6a-c; Lindqvist 1997b:372, fig. 6).

The occupational interruption during the later part of the Mesolithic indicated in figs. 17-18 (see also tab. 2) may have various causes. The most probable is that the early *Litorina* transgressions flooded the shores of the island of Stora Karlsö in such a way that it became less attractive to the grey seals. It may also have made the access to the Stora Förvar Cave entrance less convenient, which perhaps may have caused the inhabitants to move to another cave situated at a higher altitude. As has already been stated, at least three shore bound Mesolithic dwelling sites on main Gotland (Strå kalkbrott in Bunge parish, Gisslause in Lärbro parish and Svalings in Gothem parish) dated to about 6,000 cal BC had to be abandoned when they became flooded and covered by *Litorina* gravel, and a dwelling site on a higher altitude (Visborgs Kungsladugård in Visby country parish) was abandoned when the nearby shore below the *klint* was flooded (Lindqvist 1997c:102, fig. 6).

This chronological and stratigraphical *hiatus* clearly observed between the human collagen AMS-dates 7,440 BP in G.8 and 5,500 BP in G.7 (tab. 2, fig. 17-18), that is with a duration of almost two millennia, is also found among the animal bone dates. Hence, there are hitherto no animal bone dates between a salmon (*Salmo salar*) bone from G.9 AMS-dated to 7,315 ±85 BP (Ua-4192) and a cod (*Gadus morhua*) bone from G.7 dated to 5,435 ±135 BP (Ua-4956) (fig. 17). The duration of the *hiatus* in calendar years is more difficult to express, since the earlier of the AMS-dates are less affected by reservoir effects than the later dates, which may show an apparent age of 200-300 years too early (Lindqvist & Possnert 1997a:73-74, 1997c:51-64, tab. 17a-b).

The late Mesolithic AMS-dates are followed by a series of Early Neolithic AMS-dates on domestic animal collagen from G.7

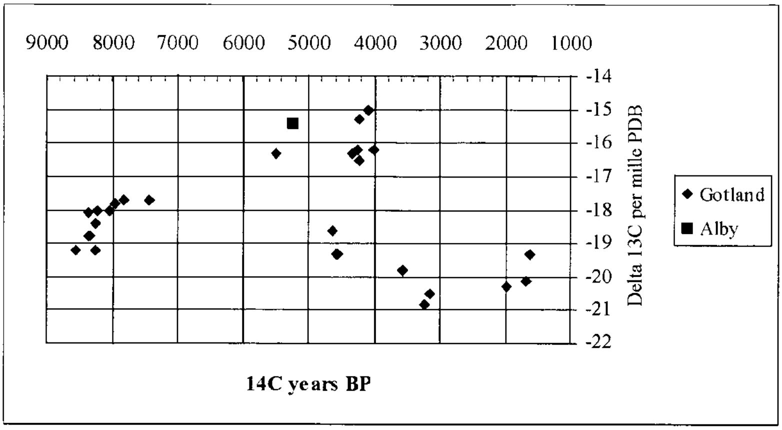


Fig. 18. [13]C- and [14]C-analysed prehistoric human bones from Gotland (including the island of Stora Karlsö). Grave 25 from Alby in Hulterstad parish on Öland is shown for comparison. (The Mesolithic dates, to the left of 5,000 BP in the diagram, are listed in Tab. 2.) The $\delta^{13}C$ values in human bone collagen were gradually rising over time, apparently reflecting the gradually rising salinity caused by the oceanic water inflow during the Litorina Sea *stage. Observe, however, the unusually rapid change during the interval ca. 8,300-8,200 BP, which probably indicates when the* Ancylus/Mastogloia-*transition occurred.*

(Lindqvist 1997b:371, fig. 5), and a series of Middle Neolithic AMS-dates on seal and domestic animal bone collagen from G.7-5(4). If the Late Neolithic finds from G.4 are included, the Neolithic cultural layer is about as thick as the Mesolithic cultural layer, that is >1 m. These Neolithic dates are followed by Early Bronze Age and Migration period AMS-dates from G.4-3 (fig. 17). There seems to be another *hiatus* with a duration of more than a millennium between the Bronze Age and Iron Age AMS-dates. However, due to the occurrence of Late Neolithic and Bronze Age pottery, mainly in G.4, the absence of dates between ca. 4,000 and 1,600 BP probably is more apparent than real. This gap, which at present includes only one AMS-date, ca. 3,300 BP on sheep bone, is likely to be filled more completely when additional datings are conducted on seal and domestic animal bones from these upper levels.

INTERPRETATIONS AND CONCLUSIONS

The ca. 120 cm thick ashy preceramic Mesolithic cultural layer in the G area of the Stora Förvar Cave including enormous amounts of bones (nearly 16,000 identified bones) of seal, fish and birds, as well as numerous flints and some stone axes, indicates that the Stora Förvar Cave was not merely a hunting station of short duration. The intensive fire making in the inner part of the cave may hardly be associated with anything else than heating and cooking during longer periods of time. Indeed, it seems already from the occurrence of a suckling baby, a 12-year old girl and two women fair to say that the occupation in the cave did not merely comprise a hunting station during a very limited season. In addition, the main grey seal cub-hunting season was apparently during the winter or spring, but the ringed seals were hunted during the late summer and autumn. The salmons (and pike) were caught during the summer half of the year, perhaps the later part. Only occasional juvenile bird and hare bones have been identified, indicating the catching of migrating aquatic birds and hares mainly during the late autumn, winter and early spring (Lindqvist & Possnert 1997c:35, tab. 3, 39-44, 51-64, 73-74, fig. 10a-c, 75-76, fig. 11; Lindqvist & Storå 1997:22-23). Taken together, this indicates that resources were available and indeed utilised more or less all the year round.

Earlier interpretations include the extreme view that the cave was merely a dump for skinned seal bodies, and that the cave was at most a temporary seal-hunting station for seal cub fur extraction (Knape & Ericson 1988; Ericson & Knape 1991). The find of skeletal remains of a suckling baby, a girl and two women in the thick Mesolithic cultural layer in the cave, however, may instead imply that the occupation was a semi-permanent base camp. Or should we interpret it the other way around: that young girls and women with suckling babies joined the men at the temporary hunting stations?

There is, however, still another hypothetical alternative: that the human remains in the cave at least partly derive from persons who had died elsewhere, and subsequently were transported to the island of Stora Karlsö. The fact that human bones, including fire-damaged cranial bones, crushed cranial bones and a frontal bone with cut-marks (fig. 14, 16), from a number of individuals of various living ages and sex have been identified among seal bones, flints, stone axes and ashes in the Stora Förvar Cave, at the same time as human bones are missing at the other Mesolithic dwelling sites on Gotland – except at Svalings, where a 4.5 ∞ 3 cm cranial fragment was identified by Elias Dahr, although the find circumstances are unclear and the bone has not been possible to retrieve (Munthe, Hede & Lundqvist 1928:87; Munthe 1954:700) – may imply that separate, burial ceremonies diverging from the formalised burial customs ('hocker' graves) at Stora Bjärs in Stenkyrka parish and Kambs in Lummelunda parish on northwest Gotland (Althin 1950; Arwidsson 1949, 1979; Munthe 1954; Larsson 1982) (see fig. 1 and fig. 19a-b) occurred in the Stora Förvar Cave on Stora Karlsö. Perhaps they took place within the framework of an ancestral cult that included some peculiar activities such as skeleting, scalping and ritual cannibalism, followed by a quite different type of disposal of human bones in the meal-scrap midden inside the cave.

The frontal bone with cut-marks and the unburnt, fire-damaged or burnt cranial bone fragments, showing signs of crushing (fig. 14, 16) are not unique finds, since Palaeolithic, Mesolithic and Neolithic human skull and postcranial bones with cut-marks etc. also occur at for example Vindija and Krapina in Croatia (Gore 1996:8), Gough's Cave, Ched-

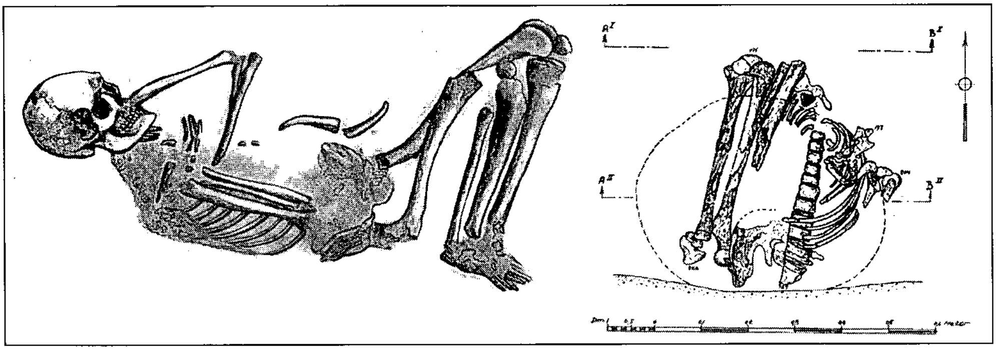


Fig. 19.a-b. The male burial from Stora Bjärs (left) and the male burial no. I from Kambs (right). The Stora Bjärs grave is AMS ^{14}C-dated on bone collagen to 6,992-6,595 cal. BC (δ^{13}C: -17.8‰ vs PDB), and a female skeleton (no. II) from Kambs is conventionally ^{14}C-dated on bone to 7,007-6,622 cal. BC (δ^{13}C: –18.0‰ vs PDB) (Arwidsson 1949, 1979; Larsson 1982).

Fig. 19.c. The male grave from Stora Bjärs in Stenkyrka parish (Photo by Raymond Hejdström, Gotlands Fornsal 1994). This individual has robust zygomatics with a wide zygomatic breadth. There are also a couple of injuries: a hole in the right parietal with signs of healing and a fresh wound in the left side of the mandible. Furthermore a slotted bone point was found in the pelvis. This male had apparently been involved in some physical conflicts resulting in injuries that ultimately caused his death. This is remarkable, since the population on Gotland during the final Boreal/ early Atlantic zone shift is apprehended as fairly small.

dar, in England (Currant, Jacobi & Stringer 1989:135 fig. 5-6), Dyrholmen and Vedbaek in Denmark (Mathiassen *et al.* 1942; Champion *et al.* 1984:109), Alvastra in Sweden (During & Nilsson 1991) and Jettböle on Åland (Nuñez 1995; Nuñez & Lidén 1997). Many of the 1907-08 excavated Late Paleolithic human skulls in the Ofnet Cave near Nördlingen in Bavaria bore the marks of blows, and these individuals – like the Alvastra pile dwelling individual – had probably been beheaded after having met a violent death (Breuil 1909; Schmidt 1912; Mollison 1936; Boule & Vallois 1957:349-350). The human bone finds in the Mesolithic part of the G area in the Stora Förvar Cave may be compared with Dyrholmen, where human bones were also found dispersed in the cultural layer, contrasting to the very formal burials at Vedbaek. Although Champion *et al.* believes that, "The very fact of formal burial at all may denote status..." (1984:109), in a subtle way implying that many humans after death may have been disposed of unceremonially in nature or in meal-scrap middens, it is curious that except at Svalings, where a human cranial fragment apparently was found among the seal bones, human bones have not been found in the cultural layers of ten other Mesolithic dwelling sites on main Gotland. (Although the subsistence economy appears to have been quite similar on main Gotland and on the island of Stora Karlsö, the natural resources, especially concerning plant food, may have been less diversified on the latter, perhaps even causing a periodically higher mortality there.) Furthermore, the only formal Mesolithic burials on Gotland are the three from Kambs and Stora Bjärs; there are hitherto no counterparts on Gotland to the burial grounds at Vedbaek in Denmark, Skateholm in south Sweden, Zvejnieki in Latvia, and Jushnij Olenij Ostrov in East Carelia (Russia). Although evidently not found in formal burials, the two skulls first found in the Stora Förvar Cave seem to have been found together with postcranial bones surrounded by rocks (a roof-fall accident?), and in 1892 Hjalmar Stolpe found "... parts of a human skeleton, (some ribs and *vertebrae*, half a pelvis, both *femora* and the lower legs and fragments of an arm) brought together in a pile ..." on the floor of the cave, probably in parcelle F or G. Stolpe interpreted these finds in terms of cannibalism, but it could perhaps have represented a skeleton 'tied together' in the same way as at Kambs, albeit disturbed. Stolpe also mentions numerous human bones, including skull bones showing signs of blows and burnt human bones, from F.11 (Schnittger & Rydh 1940:47-48). The latter human bones, which have not been possible to study and which may have been lost, could in fact belong to the same individuals as those analysed by us in the adjacent parcelle G.

It remains to be investigated whether such informal disposals of numerous dead individuals have been conducted also in other caves on the islands of Stora and Lilla Karlsö. Provided approximately the same number of individuals were disposed of in each cave (there may be more individuals than these nine if also the Mesolithic levels in the other excavation areas in the Stora Förvar Cave are included), it would mean that perhaps as many as a hundred individuals are buried on these islands, which may have comprised an analogy to such burial islands as Jushni Olenij Ostrov in East Carelia or Téviec and Hoëdic in France. Viewed from this perspective, people may have come from the dwelling sites on main Gotland to these 'islands of the dead' to bury their deceased relatives in 'sepulchral caves', which may partly have served the same function as later megalithic graves and catacombs or crypts. (Burials and scattered human bones are also known from Norwegian coastal caves, e.g. Vistehulen, Skipshelleren, Sauehelleren, Kvernevighelleren, Solsemhulen and Storbåthallaren.)

However, only excavations of other caves on the Karlsö islands can confirm this alternative hypothesis, as well as reveal new details that could better assist in the difficult task of interpretation. For the time being it is perhaps best to work with the assumption that the identified individuals once lived in the cave. The presence of women and children, the thick cultural layer, the manufacturing and use of tools, the preparation of plenty of food, that is strong indications of common subsistence activities, together with the very rare occurence of human bones and the presence of rich resources throughout the whole year, indicate that the occupation in the Stora Förvar Cave had a more permanent and important subsistence-economical character than merely a temporary hunting station, or a ritual burial cave.

English revised by Laura Wrang.

ACKNOWLEDGEMENTS

We thank the staff at the Osteological Department of the Central Board of National Antiquities/the Museum of National Antiquities in Stockholm and the Gotland Historical Museum in Visby, as well as the leaders of the project Gotland's Stone Age, Dr. Inger Österholm and Prof. Göran Burenhult, for their kindness in permitting our analyses.

NOTES ON THE PROJECT

Christian Lindqvist's archaeological investigation of the artefacts and stratigraphy of the Stora Förvar Cave began under the direction of Professor Mats Malmer in 1981/82, and after 1991/93 osteological investigations of the faunal and human remains were continued under the supervision of Professor Torstein Sjøvold and Ass. Prof. Ebba During.

The research project, *The Stora Förvar Cave and Gotland's peopling, faunal history and subsistence economy/diet development from the Boreal to the Subatlantic*, initiated by Christian Lindqvist at the Osteological Research laboratory, Ulriksdal, in 1991, soon became a interdisciplinary joint project together with Ass. Prof. Göran Possnert, Ångström Laboratory (the former The Svedberg or Tandem Laboratory), Uppsala, and later also together with Professor Svante Pääbo, Zoological Institute, Munich University. Unless otherwise stated, all carbon isotope (AMS-datings and ^{13}C) analyses of bone collagen have been conducted by Ass. Prof. Göran Possnert in Uppsala, and the osteological analyses have been conducted by Dr. Christian Lindqvist in Ulriksdal.

REFERENCES

Althin, C.-A. 1950. Bäckaskog och Lummelunda. *Technica & Humaniora*, Malmö. Pp. 13-37.

– 1951. Bäckaskog och Lummelundagravarnas ålder. *Fornvännen*. Pp. 360-364.

Anderson, M., Messner, M.B. & Green, W.T. 1964. Distribution of lengths of the normal *femur* and *tibia* in children from one to eighteen years of age. *Journal of Bone and Joint Surgery*, Vol. 46. Pp. 1197-1202.

Arwidsson, G. 1949. Stenåldersfynden från Kambs i Lummelunda. *GotländsktArkiv* Vol. XXI. Pp. 147-167.

– 1979. Stenåldersmannen från Stora Bjärs i Stenkyrka. *Arkeologi på Gotland*, Gotlandica 14. Pp. 17-25.

Bass, W.M. 1987. *Human Osteology*. A Laboratory and Field Manual. 3rd ed. Missouri Archaeol. Soc., Inc.

Beall, C.M. 1987. Nutrition and variation in biological ageing. In: F.E. Johnston (Ed). *Nutritional Anthropology*. New York: Alan Liss. Pp. 197-221.

Boule, M. & Vallois, H.V. 1957. *Fossil Men*. Thames & Hudson, London.

Breuil, H. 1909. Le gisement quaternaire d'Ofnet. *L'Anthropologie* Vol. XX.

Buikstra, J.E. & Ubelaker, D.H. (Eds). 1994. *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archaeological Survey Research Series No. 44. Fayetteville, Ark.

Byers, S., Akoshima, K. & Curran, B. 1989. Determination of Adult Stature From Metatarsal Length. *American Journal of Physical Anthropology*, Vol. 79. Pp. 275-279.

Champion, T., Gamble, C., Shennan, S. & Whittle, A. 1984. *Prehistoric Europe*. Academic Press, London.

Chisholm, B.S., Nelson, D.E. & Schwarcz, H.P. 1983. Marine and terrestrial protein in prehistoric diets on the British Columbia Coast. *Current Anthropology*, Vol. 24. Pp. 396-398.

Clark, G. 1976. A Baltic Cave sequence: A further study in bioarchaeology. In: *Festschrift für Rickard Pittioni*. Archaeologica Austracia Bh 13. Pp. 113-123.

Currant, A.P., Jakobi, R.M. & Stringer, C.B. 1989. Excavations at Gough's Cave, Somerset 1986-87. *Antiquity*, Vol. 63. Pp. 131-136.

During, E. & Nilsson, L. 1991. Mechanical surface analysis of bone: A case study of cut-marks and enamel hypoplasia on a Neolithic cranium from Sweden. *American Journal of Physical Anthropology* Vol. 84. Pp. 113-125.

Ericson, P.G.P. 1984. Faunahistoriskt intressanta stenåldersfynd från Stora Karlsö. *Fauna och Flora*, Vol. 84. Pp. 192-198.

Ericson, P. & Knape, A. 1991. Stora Karlsö – en jaktstation under neolitisk tid. *Gunneria* Vol. 64. Pp. 197-205.

Falsetti, A.B. 1995. Sex Assessment from Metacarpals of the Human Hand. *Journal of Forensic Sciences* A Vol. 40 No. 5. Pp. 774-776.

Gejvall, N.-G. 1949. Skelettmaterialet från Kamsgravfältet. *GotländsktArkiv* Vol. XXI. Pp. 168-170.

– 1970. The fisherman from Barum – mother of several children. Palaeoanthropological finds in the skeleton from Bäckaskog. *Fornvännen*. Pp. 281-289.

– 1979. Sammandrag av den anatomisk-osteologiska undersökningen av skelettet från Stora Bjärs i Stenkyrka. *Arkeologi på Gotland*, Gotlandica Nr. 14. Pp. 24-25.

Gore, R. 1996. The dawn of humans; Neanderthals. *National Geographic* Vol. 189 No. 1. Pp. 2-35.

Hansen, F. 1941. Fiskaren från Barum från äldre stenåldern. *Handlingar från Villands härad*.

Hildebrandt, W.R, & Jones, T.L. 1992. Evolution of marine mammal hunting: A view from the California and Oregon coasts. *Journal of Anthropological Archaeology*, Vol. 11. Pp. 360-401.

Hoffman, J.M. 1979. Age Estimations from Diaphyseal Lengths: Two Months to Twelve Years. *Journal of Forensic Science*, Vol. 24. Pp. 461-469.

Holland, Th.D. 1995. Estimation of Adult Stature from the *Calcaneus* and *Talus*. *American Journal of Physical Anthropology*, Vol. 96. Pp. 315-320.

Iscan, M.Y. (Ed). 1989. *Age Markers in the Human Skeleton*. Ch.C. Thomas Publ., Springfield, Ill.

Janzon, G.O. 1974. *Gotlands mellanneolitiska gravar*. Acta Universitatis Stockholmiensis, Studies in North European Archaeology Vol. 6. Stockholm. Diss.

Johnston, F.E. 1962. Growth of the Long Bones of Infants and Young Children at Indian Knoll.

American Journal of Physical Anthropology Vol. 20 No. 3. Pp. 249-254.

Jones, T.L. & Hildebrandt, W.R. 1995. Reasserting a prehistoric tragedy of the commons: Reply to R.L. Lyman. *Journal of Anthropological Archaeology* Vol. 14. Pp. 78-98.

Klepinger, L.L. 1992. Innovative approaches to the study of past human health and subsistence strategies. In: R. Saunders & M.A. Katzenberg (Eds). *Skeletal Biology of Past Peoples: Research methods*. Wiley-Liss, New York. Pp. 121-130.

Knape, A. & Ericson, P. 1983. Återupptäckta fynd från grottan Stora Förvar. *Fornvännen*. Pp. 169-175.

– 1988. Stora Förvar – kontinuitet och förändring i ett resursutnyttjande. *Gotländskt Arkiv*. Pp. 31-38.

Kósa, F. 1989. Age estimation from the fetal skeleton. In: M.Y. Iscan (Ed). *Age Markers in the Human Skeleton*. Pp. 21-54.

Larsson, L. 1982. De äldsta gutarna. *Gotländskt Arkiv*. Pp. 7-14.

Lazenby, R.A. & McCormack, P. 1985. Salmon and malnutrition on the Northwest Coast. *Current Anthropology* Vol. 26. Pp. 379-384.

Lepiksaar, J. 1974. Djurrester från den mellanneolitiska (gropkeramiska) boplatsen vid Äs, Romfartuna sn, Västmanland. In: L. Löfstrand, *Yngre stenålderns kustboplatser*. Aun Vol. 1. Pp. 140-156.

Lidén, K. 1995. *Prehistoric diet transitions*. Theses and Papers in Scientific Archaeology Vol. 1, Archaeological Research Laboratory, Stockholm University. Diss.

Lidén, O. 1942. *De flinteggade benspetsarnas nordiska kulturfas*. Skrifter utgivna av Kungliga Humanistiska Vetenskapssamfundet i Lund Vol. 33, Lund.

– 1948. *Aktuella sydsvenska stenåldersproblem: Jonstorp, Sjöholmen och Barumgraven*. Lund.

Lindqvist, C. 1983. Arktiska hällristningsbåtar – spekulationer om kulturellt utbyte via kust- och inlandsvattenvägar i Nordfennoskandia. *Meddelanden från Marinarkeologiska Sällskapet* Vol. 6 Nr. 1 1983. Pp. 2-14.

– 1984. Arktiska hällristningsbåtar och den marina anpassningen. *Meddelanden från Marinarkeologiska Sällskapet* Vol. 7 Nr. 2 1984. Pp. 4-34.

– 1991. *Aspekter på gotländsk faunahistoria i ljuset av analyserade djurbensmaterial*. Seminar Paper for Osteology II, Osteological Research Laboratory, Department of Archaeology, Stockholm University.

– 1994. *Fångstfolkets bilder. En studie av de kustanknutna Nordfennoskandiska jägarristningarna*. Theses and Papers in Archaeology N.S. A 5, Dept. of Archaeology, Stockholm University. Diss.

– 1997a. Ansarve hage-dösen. Tvärvetenskapliga aspekter på kontext och den neolitiska förändringen på Gotland. In: A. Åkerlund *et al.* (Eds). *Till Gunborg; Arkeologiska samtal*. Stockholm Archaeological Reports No. 33. Pp. 361-378.

– 1997b. About the importance of fine-mesh sieving, stratigraphical and spatial studies for the interpretation of the faunal remains at Ajvide, Eksta parish, and other Stone Age dwelling sites on Gotland. In: G. Burenhult (Ed). *Remote sensing*, Vol. I. Theses and Papers in Archaeology Vol. 13:i, Department of Archaeology, Stockholm University. Pp. 91-111.

Lindqvist, C. & Possnert, G. 1997a. Om reservoareffektproblemet. In: G. Burenhult (Ed). *Ajvide och den moderna arkeologin*. Natur och Kultur. Pp. 73-74.

– 1997b. Ajvidebornas kost under gropkeramisk tid enligt kolisotopen Kol-13 och faunamaterial. In: G. Burenhult (Ed). *Ajvide och den moderna arkeologin*. Natur och Kultur. Pp. 152-153.

– 1997c. The subsistence and diet at Jakobs/Ajvide and Stora Förvar, Eksta parish, and other Stone Age dwelling and burial sites on Gotland. In: G. Burenhult (Ed). *Remote sensing*, Vol. I. Theses and Papers in Archaeology Vol. 13:i, Department of Archaeology, Stockholm University. Pp. 29-90.

Lindqvist, C. & Storå, J. 1997. Havet och sälarna. In: G. Burenhult (Ed). *Ajvide och den moderna arkeologin*. Natur och Kultur. Pp. 22-23.

Lithberg, N. 1914. *Gotlands stenålder*. Stockholm. Diss.

Lyman, R.L. 1995. On the evolution of marine mammal hunting on the West Coast of North America. *Journal of Anthropological Archaeology* Vol. 14. Pp. 45-77.

Malmer, M.P. 1962. *Jungneolithische Studien*. Lund. Diss.

Masset, C. 1989. Age estimation on the basis of cranial sutures. In: M.Y. Iscan (Ed). 1989. *Age*

Markers in the Human Skeleton. Pp. 71-103.
Mathiassen, T., Degerbøl, M. & Troels-Smith, J. 1942. *Dyrholmen*. En stenaldersboplads pa Djursland. Det Kongelige Danske Videnskapers Selskab, Archaeologisk-Kunsthistorisk Skrifte 1,1. Copenhagen.
Mollison, T. 1936. Zeichen gewaltsamer Verletzungen an den Ofnet-Schädeln. *Anthropologischer Anzeiger* Vol. XIII.
Munthe, H. 1940. *Om Nordens, främst Baltikums, senkvartära utveckling och stenåldersbebyggelse.* Kungl. Sv. Vetenskapsakademiens Handlingar 3:e Ser. Bd. 19 No.1. Diss.
– 1954. Stora Bjersfyndet i relation till några andra fynd från äldre stenåldern på Gotland. *Geologiska Föreningens Förhandlingar* Vol. 76 No. 4. Pp. 697-702.
Munthe, H., Hede, J.E. & Lundqvist, G. 1928. Beskrivning till kartbladet Slite. *Sveriges Geologiska Undersökning* Ser. Aa No. 169. Pp. 86-87.
Musgrave, J.H. & Harneja, N.K. 1978. The Estimation of Adult Stature from Metacarpal Bone Length. *American Journal of Physical Anthropology* Vol. 48. Pp. 113-120.
Møhl, U. 1971. Fångstdyrene ved de Danske strande; den zoologiske bakgrund for harpunene. *Kuml* 1970. Pp. 297-329.
Nihlén, J. 1927. *Gotlands stenåldersboplatser.* KVHAA Handlingar, Del 36:3, Stockholm. Diss.
Nuñez, M. 1995. Cannibalism on Pitted Ware Åland? *Karhunhammas* Vol. 16. Pp. 61-68.
Nuñez, M. & Lidén, K. 1997. Taking the 5,000 year old 'Jettböle skeletons' out of the closet: A palaeo-medical examination of human remains from the Åland (Ahvenanmaa) Island. *International Journal of Circumpolar Health* Vol. 56. Pp. 30-39.
Pira, A. 1926. On bone deposits in the cave Stora Förvar on the Isle of Stora Karlsö, Sweden. *Acta Zoologica* Vol.VII.
Retzius, G. 1890. Om de i grottan Stora Förvar funna menniskokranierna. *Ymer* Vol. 10. Pp. 286-287.
Rydh, H. 1931. *Stora Karlsö under forntiden.* Stockholm.
Rösing, F.W. 1988. Methoden und Außagemöglichkeiten der Anthropologischen Leichenbrandbearbeitung. In: R. Knußmann (Ed). *Anthropologie*, Bd. I, *Wesen und Methoden der Anthropologie*, 1. Teil. Stuttgart. Pp. 53-80.
Schmidt, R.R. 1912. *Die diluviale Vorzeit Deutschlands.* Stuttgart.
Schnittger, B. & Rydh, H. 1940. *Grottan Stora Förvar på Stora Karlsö.* KVHAA, Stockholm.
Sjøvold, T. 1974. Some Aspects of Physical Anthropology on Gotland during Middle Neolithic Times. In: G.O. Janzon, *Gotlands mellanneolitiska gravar.* Studies in North-European Archaeology Vol. 6, A & W, Stockholm. Pp. 176-211.
Sorg, M.H., Andrews, R.P. & Iscan, M.Y. 1989. Radiographic ageing of the adult. In: M.Y. Iscan (Ed). *Age Markers in the Human Skeleton.* Pp. 169-194.
Steel, D.G. 1976. The Estimation of Sex on the Basis of the *Talus* and *Calcaneus*. *American Journal of Physical Anthropology* Vol. 45. Pp. 581-588.
Stenberger, M. 1964. *Det forntida Sverige.* Stockholm.
Stloukal, M. & Hanákovà, H. 1978. Die Länge der Längsknochen altslawischer Bevölkerungen unter besonderer Berücksichtigung von Wachtumsfragen. *Homo* Vol. 29. Pp. 53-69.
Stringer, C. & Gamble, C. 1994. *In Search of the Neanderthals.* Thames & Hudson, London.
Szilvássy, J. 1988. 4. Altersdiagnose am Skelett. In: R. Knußmann (Ed). *Anthropologie*, Bd. I, *Wesen und Methoden der Anthroplogie*, 1. Teil. Stuttgart. Pp. 421-433.
Thieme, F.P. 1957. Sex in Negro skeletons. *Journal of Forensic Medicine* Vol. 4. Pp. 72-81.
Thompson, D.D., Posner, A.S., Laughlin, W.S. & Blumenthal, N.C. 1983. Comparison of bone apatite in osteoporotic and normal Eskimos. *Calcification Tissue Int.* Vol. 35. Pp. 392-393.
Ubelaker, D.H. 1989. The estimation of age at death from immature human bone. I: M.Y. Iscan (Ed). *Age Markers in the Human Skeleton.* Pp. 55-70.
Warwick, R. & Williams, P.L. (Eds). 1973. *Gray's Anatomy.* 35th ed. Longman.
Welinder, S. 1971. Några reflexioner kring Barumgraven. *Fornvännen.* Pp. 92-95.