The Mesolithic Double Burial from Öland, Sweden

Sandra Fritz[1,4], T. Douglas Price[2], Karina Hammarstrand Dehman[3], Helene Wilhelmson[3] and Lars Larsson[1]

[1] Department of Archaeology and Ancient History, Lund University, Helgonavägen 3, SE-223 62 Lund, Sweden.
[2] Laboratory for Archaeological Chemistry, 1180 Observatory Drive, University of Wisconsin-Madison, Madison WI 53706 USA
[3] Sydsvensk Arkeologi AB, Erlandsrovägen 5, SE-218 45 Vintrie, Sweden.
[4] Corresponding Author (sandra.fritz@ark.lu.se) ORCID 0009-0009-5206-8561.

ABSTRACT

Mesolithic double burials in Scandinavia are rare. Half a dozen has been found in Sweden and equally many in Denmark. In many cases, these contain one adult and one child or were initially intended for single burials where an additional individual was later deposited. On Öland, Sweden, a double burial containing two men was discovered in 1948. The men were buried simultaneously and placed as if they were holding hands. The double burial was positioned underneath an Iron Age urn burial and was discovered by accident; the only temporal indication of the burial was a lining of red ochre within the bottom of the grave. This study examines the individuals based on radiometric dating; isotope analyses focused on mobility and diet; and presents osteological profiles of the deceased. Results have determined that the individuals derive from the Late Mesolithic and had diets consisting of a high intake of marine proteins. One of the men had reached an age of approximately 64 years and had non-local provenience whereas the other man died in his late teens and was likely raised locally, even so, possibly related to each other. Both men displayed skeletal traits indicative of trauma and physical strain.

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Introduction

Just outside the southeast coast of Sweden, the islands of Gotland and Öland are situated. Öland represents the smaller of the two and is situated connected to the mainland by the Öland bridge which stretches 6 km from the mainland over the Kalmar sound. Alby-Triberga, where the double burial was found, is located in the southeastern part of the island, an area that today consists mostly of boglands (Figure 1). This part of Öland has a very flat topography lined with beach ridges that marks artefacts of the Ancylus and Littorina Baltic pre-stages. The area was part of the Ancylus beach ridge systems in *c.*6800 BC and part of the Littorina transgression following some thousand years later. The ridges vary in size along the coastline but can reach up to five metres at certain places. The bedrock consists of Ordovician limestones karstified by fissures that have been created through alternate cracking in connection with tectonic events. The different layers formed by different events in the bedrock have most likely been created through weathering (Königsson *et al.* 1993, 14–15). The soil in the area are remnants of transgressional activities and consists of gravel and marsh peat bogs. The Alby-Triberga vicinity holds an abundance of historic and prehistoric remnants, in fact, the entire island of Öland represents historical and prehistorical events stretching from the Middle Mesolithic and onwards.

In connection with the mining of gravel and peat in the area between 1939-1955, several archaeological excavations were conducted in Alby-Triberga, uncovering several graves deriving from different prehistorical periods. The area was reportedly marked with eight granite monoliths, the majority of which had been overturned. The graves consisted of one cist tomb, three graves containing skeletal remains: two urn burials and three ground burials. Two of the ground burials were analysed and one was typologically dated to the Viking Age. Both urns contained artefacts from the Early Roman Iron Age. One of the urns was covering a double burial which

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Figure 1. Map of the southwest Baltic Sea area with Alby-Triberga marked with a green point on the island of Öland (Figure: Helene Wilhelmson).





Figure 2. The double burial in Alby-Triberga with individual 1050 placed on the left and 1049 on the right (Photo: A.S. Lindsten, 1948, Reproduced with permission).

was discovered as the urn was removed in 1948 (L1958:5875), (Schotte-Lindsten 1948; Königsson *et al.* 1993; Schulze 2006). The double burial contained two individuals in supine positions, in NW-SE direction toe to head and were placed, seemingly holding hands (Figure 2). The grave did not contain any other detectable items that might have provided typological dating, however presented colorations in accordance with presence of red ochre (Schotte-Lindsten 1948). The buried were exhumed and all finds were sent to the National Antiquities Office in Stockholm and the landowner was requested to resume contact if additional graves were found.

In archaeological terms, Öland is mostly affiliated with Iron Age remnants. The island is famous for its many ringforts, stone house foundations, stone fences and cemeteries containing thousands of graves from the Roman Iron Age and Migration Period (Alfsdotter *et al.* 2018). However, the island has proven to have been occupied by human activities for far longer than the Iron Age (Alexandersson 2004). Several Mesolithic graves have been identified on the island, located on both the northeast and southwest coastal areas (Table 1, Figure 3).

Excavations in 2007 in Tings ene, Köpingsvik (L1957:2031) uncovered a grave in which the bones were in a too poor state to date. However, a

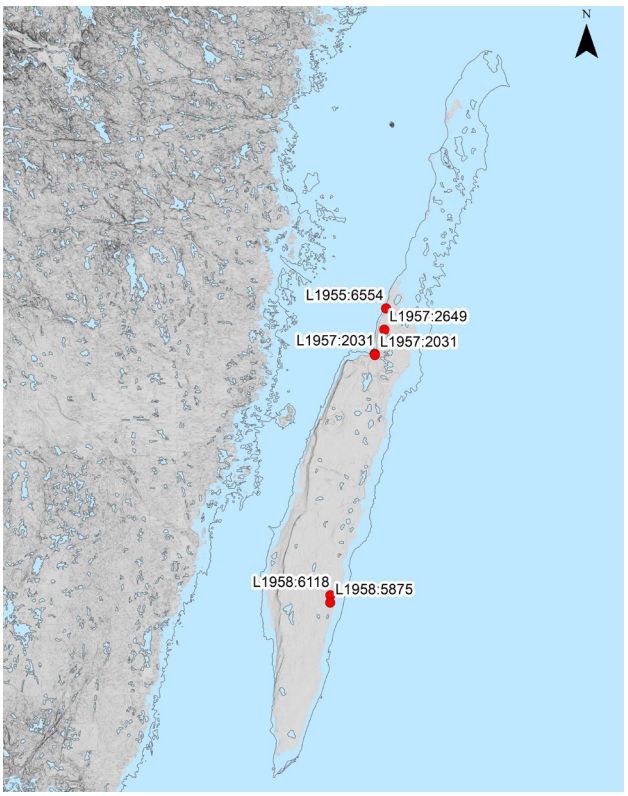


Figure 3. Map indicating the Late Mesolithic shoreline of Öland and documented Mesolithic graves on Öland marked with red dots (Figure: Karina Hammarstrand Dehman).

Inv. No	Lab. no	Site	Material	BP	±	Marine cal (Y/N/U)	Cal BC 2σ	Δ13C (‰)	Ref.
L1955:6554	N/A	Alböke 115	Context	N/A	N/A	N/A	Late Meso	N/A	Alexandersson 2017
L1957:2649	Ua-36823	Köping 189:2	Bone	8030	55	N	7132–6699	-18.8	Fallgren *et al.* 2009
L1957:2031a	Ua-34975	Köping 215:1	Charcoal	5255	40	N/A	4230–3970	N/A	Papmehl-Dufay 2008
L1957:2031b	Ua-32180	Köping 215:1	Bone	5580	60	N	4534–4335	-14.8	Papmehl-Dufay 2006
L1958:6118	A: Ua-1713 B: Ua-2333	Hulterstad 114:1 (Alby)	A: Tooth B: Bone	A:5200 B:5260	A:150 B:70	A: N B: N	A: 4349–3699 B: 4314–3958	A: N/A B: -15.4	Königsson *et al.* 1993

Table 1. Previously investigated Mesolithic graves from Öland.

piece of underlying charcoal dated the context to the late Mesolithic (4230-3970 calBC, Ua-36975). Also, from Köpingsvik, another grave was uncovered in 1970 (L1957:2031b) containing a single human mandible that was dated to 4534–4335 calBC (Ua-32180), (Papmehl-Dufay 2008, 30). The oldest currently known grave is also located in the Köpingsvik area (Övra Vannborga, L1957:2649). The grave had been disturbed in its uppermost part, but it was possible to establish that the individual had been placed in a seated position. Part of a tibia was dated to the Middle Mesolithic (7132-6699 calBC, Ua-36823) (Fallgren *et al.* 2009; Alexandersson *et al.* 2018). Another grave, presumed to date to the later part of the Mesolithic, has been identified north of Köpingsvik (L1955:6554). This grave has not been directly dated, but it was found beneath an occupation layer dating to the Late Mesolithic, and its chronological attribution should therefore be regarded as uncertain (Alexandersson 2017).

In the Alby-Triberga area, 1.5 kilometers from the site where the Mesolithic double grave was discovered, a single grave has also been identified (L1958:6118), (Königsson *et al.* 1993, 34, Alexandersson *et al.* 2018). This grave contained one individual, dating to the transition between the Late Mesolithic and the Early Neolithic periods (4314–3958 calBC, Ua-2333). An adjacent Mesolithic settlement has also been identified in connection with the grave. Archaeological finds include lithic, bone, and antler tools from the middle and late part of the Mesolithic (Königsson *et al.* 1993).

Mesolithic Double Burials in Scandinavia

From a Scandinavian perspective there are several late Mesolithic double burials coinciding with that from Alby-Triberga. Regarding Swedish territories, the majority can be found within the two burial grounds of Skateholm in the southernmost part of the country. These are dated between 5200–4800 calBC (Larsson 1988, 1989, 1993). No burial placement corresponding to that in Alby can be confirmed. One double burial, grave 63 Skateholm I, contains two men of roughly similar age placed in crouched positions, one behind the other. This is a strong indication for them being buried simultaneously. The odontological examination suggests close kinship between the two (Persson and Persson 1988, 92). Close contact in double burials can also be found in grave 41 Skateholm I. An older man in a crouched position is embracing a 4–5-year-old child. In another grave, grave XII Skateholm II, two children at the ages of 2 and 4 years, had been placed together; the older child in a seated position with the younger child at its side.

Close contact, however, without contiguity, can be observed in Grave X Skateholm II, in which one man has been placed in a supine position and the other diagonally seated in the burial pit. However, hesitancy is to be considered for a couple of burials where the positions suggest initial single burials that after a short period of time have been added by a secondary burial. This is the case for grave 14 Skateholm I. The grave contains a man in a supine position as well as a woman in a supine placement but partly laying on her side. For the man, the lower extremities in the centre of the burial pit have been moved and the rest of the body have been angled towards the walls of the pit in order to make room for the woman. The woman has then been placed on her side so that the arms have been resting on top of the man's chest. This indicates that the woman has been deposited some time after the man has been buried and that the man's body has partly been pushed aside by the secondary burial of the woman. There might also be doubt regarding grave 41 Skateholm I, in which a teenage boy and a 1-year-old child are buried. The child has been placed to the left of the teenager, pushed into the middle of the long side of the burial pit. On the Swedish west coast, near Uleberg in Bohus County, skeletal remains from an adult male and a younger woman were noticed in a gravel quarry (Niklasson 1933, 216). The individuals had been placed in a partly stone-walled pit. Radiometric dating from a bone from the grave has yielded a dating of 4940±100 BC (5984–5626 calBC, St-2440) (Wigforss 1968, 4).

Within Denmark, a few double burials have been detected. Most noted is grave HB:8 in the burial ground of Bøgebakken situated by the Zealand east coast (Albrethsen and Brinch Petersen 1977). The grave contained an adult woman and a 3-year-old child, the child was placed on top of a swan's wing. Near Dragsholm in northern Zealand, an older woman had been placed on the right side of the burial pit, her arms resting along its sides while a young woman had been placed in a supine position with slightly bent knees to the left side of the pit. The ages of death were 40 to 50 years and 18, respectively (Brinch Petersen 1974, 112). Carbon-14 dating of the grave suggests 6175±49 BP (4720–4499 cal BC, AAR-7415) (Price *et al.* 2007, 218). Dietary isotopes, however, indicated high intake of marine proteins ($\delta^{13}C$= -11.47), and when calibrated in OxCal using a local marine reservoir age of R(t) = 273 ^{14}C years and the IntCal20 calibration curve, the date corresponds to 4943–4709 cal BC. This indicates that the burial was made during the very latest part of the Mesolithic period. Genetic studies have since identified the two women as mother and daughter (Allentoft *et al.* 2024).

While excavating a submarine settlement by Tybrind Vig on the southwestern part of Funen, a grave containing a young woman placed in a supine position was discovered. A child had been placed with its head on top of the woman's right shoulder and stretched diagonally over her thorax (Trolle 2017, 415). The grave was ^{14}C-dated to 6550±80 BP (5630-5336 calBC, K-3558) (Andersen 2017, 76). By Nivå lagoon, north of Bøgebakken at the Zealand Öresund coast, 12 graves were discovered of which three were double burials (Lass Jensen 2016). In grave A129 lay a man, 25–30 years old along with a 3–4-year-old child. The child was compressed at the left side of the man which was ^{14}C-dated to 7265±38 BP (6227–6035 calBC, AAR-14934). Grave A137 contained a man 25–30 years old and a 16–18-year-old female. The man's shoulders were pushed together as if he had been wrapped in some sort of perishable material (Nilsson Stutz 2003, 297). In the third double burial, A151, a man aged 25–30 years was placed and to his left side, a 30–40-year-old woman. The man also appears to have been entombed in this grave. There are indications for two of these graves having been initially intended for single use but later been used for secondary depositions. This applies for grave A129 where the child has been placed later and for grave A137, most likely intended for the young female. That the male was deposited at a later stage is indicated by the fact that the grave was initially dug too short so that the man had to be buried with bent lower extremities.

Stable Isotopes

Stable isotopes used for interpreting dietary compositions include $\delta^{13}C$ (carbon) and $\delta^{15}N$

(nitrogen). Stable carbon isotope values for $\delta^{13}C$ differentiate terrestrial protein and C3-plants from marine protein and C4-plants. Plants from the C4 subgroup do not occur naturally in Scandinavia which simplifies interpretations of coinciding values. Nitrogen stable isotopes $\delta^{15}N$ values disclose the trophic level of protein foodstuffs and by applying a biplot approach, the isotope composition of both carbon and nitrogen can be used as a guide to interpret paleodietary makeup (Eriksson *et al.* 2008). Paleodietary studies often measure isotopes in bone or dentine collagen, which reflects the protein composition of the diet where bone collagen reflects the average protein intake throughout an individual's lifetime, and dentine collagen is limited to the time of the dentine formation, *i.e.* the childhood (Lidén *et al.* 2004). Isotopes measured from apatite on the other hand reflect the overall composition of the diet, including carbohydrates, fats and proteins (Harrison and Katzenberg 2003; Ahlström and Price, 2021). Minor changes in isotope values over time or regional patterns for populations across Europe are likely to be due to environmental factors or behavioural factors regarding isotopic variation (Van Klinken *et al.* 2000). Therefore, comparisons between populations have the most potential for interpreting past dietary compositions.

Isotopic proveniencing is a method for answering questions about the place of birth for archaeological or forensic burials. Many isotopes become part of the human skeleton from the food that was eaten. Isotopic ratios of strontium, lead, oxygen, and sulfur have been used for isotopic proveniencing. Isotopic ratios of these elements vary geographically. Tooth enamel forms during gestation and early childhood and does not change, in contrast to bone which chemically turns over during lifetime. These elements (except for sulfur) are present in enamel and can be used to infer place of birth. Strontium, reported as the ratio $^{87}Sr/^{86}Sr$, is the most commonly used element in such studies. Strontium is chemically similar to calcium and sometimes substitutes for that element in the formation of enamel and bone. Because ^{87}Sr forms through a radiogenic process as a product of the decay of rubidium-87, older rocks with more rubidium have a higher $^{87}Sr/^{86}Sr$ value, while younger rocks with less rubidium are at the opposite end of the range. Regions with old rocks have more ^{87}Sr than regions with relatively younger rocks. This ratio generally varies with geology and is not significantly altered by biological processes, so that the $^{87}Sr/^{86}Sr$ ratio in enamel (or petrous bone) more or less reflects that of the underlying geology and food chain where an individual was born and raised as the enamel (or petrous bone) formed. Analytical methods are described in detail in a number of publications (*e.g.*, Frei and Price 2012, Price *et al.* 1994, Slovak and Paytan 2012, Sjögren *et al.* 2009). Numerous examples of the application of strontium isotope ratios to archaeological questions have been published (*e.g.*, Hedman *et al.* 2009, Knudson 2008, Montgomery et al. 2003, Price *et al.* 1994, 2011, Wright 2005). Some authors have even referred to a Golden Age of strontium research (Britton *et al.* 2022). However, the method is still experimental and there are a number of problems yet to be resolved.

Oxygen has three isotopes – ^{16}O (99.762% in nature), ^{17}O (0.038%), and ^{18}O (0.2%) – all of which are stable and non-radiogenic. Isotope measurements of oxygen are reported as a ratio of one isotope to another, lighter, and more abundant cousin. Oxygen isotopes are commonly reported as the per mil difference (‰ or parts per thousand) in the ratio of ^{18}O to ^{16}O between a sample and a standard. This value is designated as $\delta^{18}O$. Oxygen isotopes vary geographically in surface water and rainfall (Dansgaard 1964) and have been widely used as a proxy for temperature in many climate and environmental studies. Oxygen isotopes in archaeology are used primarily to study ancient environments and to examine past human mobility. Drinking water is the major source of oxygen deposited in the human skeleton. Oxygen isotopes in ancient human skeletal remains are found in both tooth enamel and bone. Oxygen isotopes are incorporated into dental enamel (or petrous bone) during early life and ratios remain largely unchanged through adulthood. Samples for the analysis of human skeletal remains are normally taken from dental enamel due to better preservation, resistance to diagenesis, and childhood signal. Oxygen isotopes, like strontium isotopes, are also present in bone apatite and are exchanged through

Inv. No	Lab. no	Site	Material	BP	±	Marine cal (Y/N/U)	Cal BC 1σ	Cal BC 2σ	Δ13C (‰)
L1958:5875a	LuS-10548	Hulterstad 64:1	Bone	5515	50	Y (-275)	4222-3977	4234–3962	-15.5
L1958:5875b	LuS-10549	Hulterstad 64:1	Bone	5477	50	Y (-263)	4156-3964	4230–3950	-15.3

Table 2. Datings of individuals 1049 and 1050 from the double burial in Alby-Triberga.

the life of the individual during bone turnover, thus reflecting place of residence in the later years of life. There remain substantial problems using $\delta^{18}O$, either carbonate or phosphate, for geographic proveniencing. As Price (2015) and others (*e.g.*, Freiwald 2023, Lightfoot and O'Connell 2016, Pederzani and Britton 2019) have noted, oxygen isotopes are quite variable in human remains, Lightfoot and O'Connell (2016) concluded that identifying individuals' homelands on the basis of oxygen isotope analysis alone was not possible for most of Europe. Oxygen isotope proveniencing remains controversial. Because of the potential limitations with oxygen, we have focused on strontium isotopes in this study.

Material and Methods

Determination of biological sex in young adults can be problematic since specific characteristic traits are still in development. Distinct female traits of the pelvis can be considered valid, however, distinct male traits can be a result of late osteogenic development and should be considered as uncertain and ambiguous (Buikstra and Ubelaker 1994, 16; Séguy and Buchet 2013, 33). Advances in amelogenin peptide analyses make it possible to determine sex from dental enamel (Stewart *et al.* 2017). This method is especially suitable for young individuals and in cases where the pelvic bones are not preserved, but the teeth are. Age-at-death was estimated using Transition Analysis 3 (Milner *et al.* 2021, available at https://www.statsmachine.net/software/TA3/). The skeletons were visually assessed, and indications of pathology or trauma were documented. In cases where trauma was suspected, X-ray imaging was performed at the Radiology department of Skåne University Hospital in Malmö. To present osteological profiles for the buried individuals, factors such as age and sex were examined. Amelogenin peptide-analysis was conducted at the Mass Spectrometry Laboratorium at Brighton University. Stable isotopes identifying dietary composition and proveniencing was executed at the Stable Isotope Laboratory Department of Geosciences and Natural Resource Management at the University of Copenhagen University using a Micromass Iso Prime Isotope Ratio Mass Spectrometer. Strontium isotope analysis was performed using a thermal ionization multiple collector mass spectrometer (TIMS) at the University of North Carolina. Carbon-14 dating was carried out at the Radiocarbon Dating Laboratory at Lund University. The radiocarbon ages were first corrected for marine reservoir effects by subtracting 275 and 263 radiocarbon years, respectively by using the Marine20 calibration curve (Olsson 1980; Lougheed *et al.* 2013), and were subsequently calibrated using the OxCal version 4.4.4 software (Bronk Ramsey 2021), and the IntCal20 calibration curve (Reimer *et al.* 2020).

Results

The dating of the skeletons was determined to be 4234–3962 calBC (LuSNo 10548) and 4230–3950 calBC (LuSNo 10549), respectively, including marine reservoir effect. Marine reservoir effect for individual 1049 was calibrated for waters in the Öland area; therefore 275 years were subtracted from the original dated values. Provenience for individual 1050 was more difficult to determine, for that reason the marine calibration included waters from both the Baltic Sea and the Gulf of Bothnia, adjusting the dating by -263 years (Table 2). Both individuals were subsequently dated

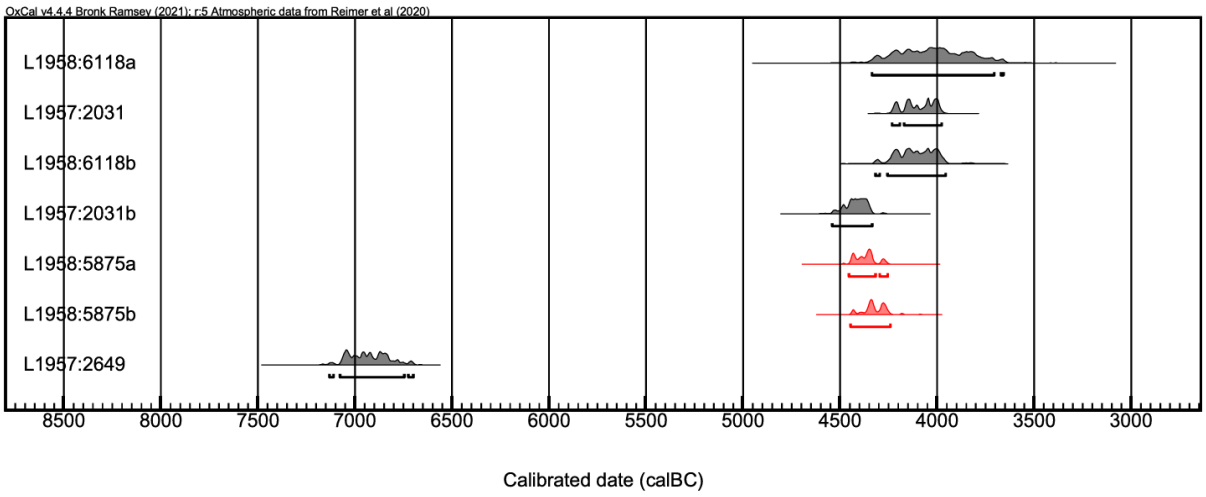


Figure 4. Calibrated 14C-datings for the documented Mesolithic graves on Öland. The individuals from the double burial in Alby-Triberga are marked red.

to Scandinavian Late Mesolithic time. Calibration curves of all known and dated Mesolithic findings are presented in figure 4, however as other findings do not present isotopic provenience values, marine reservoir effect has only been calculated for individuals 1049 and 1050.

The Juvenile, ID1049

The age at death for the young adult was determined using the TA3 method as 15.2 years old ([15.2–22.9 years], SE: 9,2. Corr [age and Pred Age: 0,883]). Traditional age assessment methods for juveniles are mostly based on epiphyseal fusion since the variation in fusion varies within relatively short time spans. The epiphyseal fusion in the humerus and femur represents an age between 12–19 years with an inclination towards the older part of the scale (Cunningham *et al.* 2016). Dental eruption is also used as an age determination method for the same reasons as for epiphyseal fusion. The young adult individual exhibits completely erupted dentition. In modern populations, the third molar erupts between 16–18 years of age, probably earlier during the Mesolithic (Sten *et al.* 2000, 77). Based on these estimates, the age of ID1049 was likely between 15–19 years at the time of death. Sex indicating traits of the young individual were ambiguous both in the innominates and the crania. A proteomic amelogenin-peptide-analysis was carried out at the University of Brighton for an upper premolar (P2+, lab no. 24038), identifying protein isoforms conclusive with male traits. The individual displayed several indicators of trauma and disease in the upper limbs. The neural arch of the first vertebrae was unfused in accordance with a cleft or bifid arch, which is a congenital malformation of unknown etiology but can also be interpreted as a fracture with nonunion and pseudoint (Figure 5) (Hunt and Mann 2012, 94; Lewis 2018, 32). The malformation had in either way resulted in secondary osteoarthritis in facet joints of the cervical vertebrae (C1-C2, C3-C4) and intervertebral lesion-herniation in C4-C5 bodies with a circular defect when combining the two bodies.

Further, the joint surface of the right scapula displayed *osteochondrosis*, a condition with an idiopathic cause that sometimes is connected to trauma and most often affects male individuals (Aufderheide *et al.* 1998, 83). The medial epiphyses of the clavicles exhibited deep conical divots, also connected to trauma or idiopathy. The lateral part of the right diaphysis had a markedly different angulation/curvature with a more irregular shape and thickening in the anterior-posterior plane. There was a protrusion of the margin towards the anterior plane in site that represented a well healed parietal fracture in the lateral part starting at midline with a slight displacement towards the inferior plane (Figure 6). The affected surface was damaged but some irregular longitudinal deposition of bone on the



Figure 5. The first vertebra (atlas) belonging to individual 1049 depicting non-union of the neural arch (Photo: Sandra Fritz).

inferior surface was visible. Additionally, the dental wear of the incisors and premolars indicated heavy chewing or softening preparation of craft materials. The teeth were worn and rounded lingually, often associated with stretching and twining leather strings or plant fiber, referred to as cobbler wear (Sten *et al.* 2000, 77).

The mature Adult, ID1050

The mature adult individual was calculated to have died at an age of 64.2 years, according to the TA3 method ([43.9-83.9 years]) SE:8,7. Corr [age and Pred Age: 0,893]). The dental status of the individual was indicative of mature age. Biological sex assessment based on both innominates and cranium clearly displayed male morphology. The maxillary teeth were represented by right and left canines, right and left first premolars, right second premolar and right and left first and second molars, all heavily worn and a slight presence of calculus was visible. Both maxillary third molars displayed dental agenesis. In the mandible, both third molars had erupted but were nearly unaffected by wear, presumably due to maxillary third molar agenesis. Apart from the mandibular third molars, all other teeth were present and heavily worn (Figure 7).

The mandibular incisors were worn labially, indicating maxillary overbite. There were no indications of periodontal disease or tooth loss, however some teeth barely held any remaining enamel. In cases where dentine was exposed, secondary

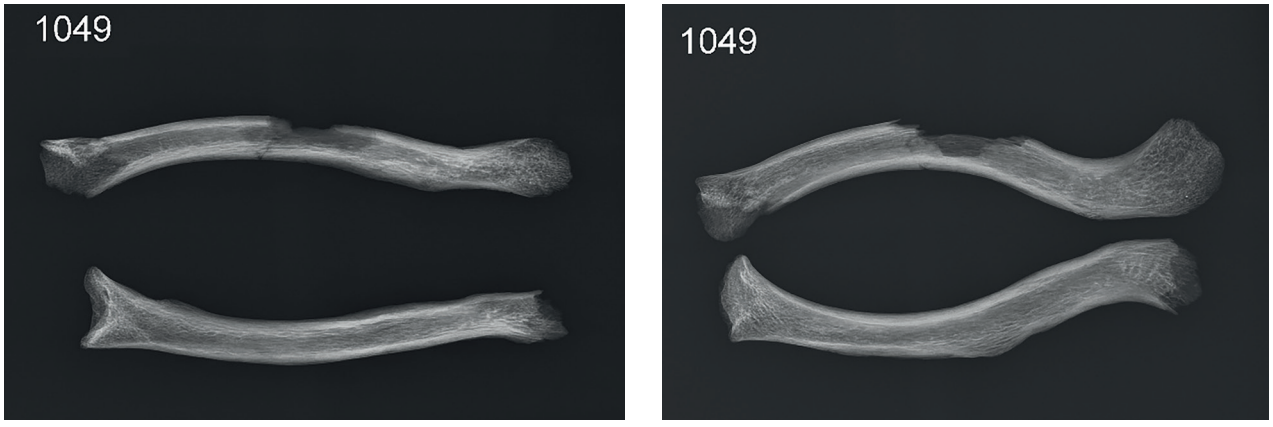


Figure 6. X-ray of both clavicles belonging to individual 1049 indicating healed fracture in the right clavicle and thickened and irregular lateral curvature (upper clavicle) (Photo: Helene Wilhelmson).



Figure 7. Left maxilla and mandible belonging to individual 1050. Teeth are heavily worn (Photo: Sandra Fritz).



Figure 8a and b. Frontal bone belonging to individual 1050 indicating thickening of left supraorbital area (Photo: Sandra Fritz).

dentine had been formed to protect the dental nerves (Nudel *et al.* 2021). Secondary dentine was identified in both mandibular first molars. The mature adult individual was, like the young adult, affected by trauma and disease. Left supraorbital margin had a significant ossification, likely caused by trauma that left the bone thickened and deformed (Figure 8).

The left medial clavicular epiphysis presented several porosities. Left glenoid surface joint had ambient lipping. Both epiphyses of the first metacarpal in the left hand were also affected by lipping. These combining factors indicated an increased strain toward the left side of the body and might indicate repeated left-handed activities. In the left foot, the first metatarsal with adjacent phalanges was lipped and crooked laterally. Parts of the lumbar vertebrae (L2 and L3) as well as ribs (left no. 7 and 8) were affected by pitting and lipping. Several skeletal elements had extensive *entesophytes* (abnormal bone growth in muscle attachment), these elements included the proximal anterior diaphysis of *humeri*, *costoclavicularis* (right), *clavicular-acromiale* (right), *subscapularis* (left and right), *latissimus dorsi* (left and right) and *pectoralis major* (right).

Isotope Analyses

Various isotope ratios were measured on the double burial from Alby-Triberga (Table 3). The young

	1049	Lab. no	1050	Lab. no
87Sr/86Sr	0.712727	F7911	0.747043	F7912
δ18Oenamel	-7.0496	HW_2013_OrgCN_1049	-7.2641	HW_2013_OrgCN_1050
δ18Oapatite	-8.3071	HW_2013_OrgCN_1049	-6.1012	HW_2013_OrgCN_1050
δ13Cenamel	-11.3138	HW_2013_OrgCN_1049	-11.4412	HW_2013_OrgCN_1050
δ13Ccollagen	-15.5198	HW_2013_OrgCN_1049	-15.3394	HW_2013_OrgCN_1050
δ13Capatite	-9.6168	HW_2013_OrgCN_1049	-9.0799	HW_2013_OrgCN_1050
δ15Ncollagen	14.5052	HW_2013_OrgCN_1049	14.5556	HW_2013_OrgCN_1050

Table 3. Isotopic values for the analyses performed on bone and teeth from the double burial in Alby-Triberga.

adult, ID1049, the 15-year-old male, 0.7127, and the mature adult, ID1050, the 64-year-old male, 0.7470. $\delta^{18}O_c$ for the two burials were -7.049 and -7.264 respectively. The strontium isotope analyses were performed on either of the individuals' premolar tooth enamel. Dietary isotopes were very similar between the two individuals; $\delta^{13}C_{collagen}$ was -15.51 and -15.34; $\delta^{15}N$ was 14.51 and 14.56. Values for $\delta^{13}C_{apatite}$ were -9.6‰ and -9.1‰, indicating a high intake of marine proteins. Although $\delta^{13}C$ and $\delta^{15}N$-values appears to be quite similar for both individuals, the strontium values for places of birth are quite different. While the young adult male (ID1049) appears to be of local extraction, a location for the high value has proven difficult to identify. Extensive isoscape mapping of bioavailable strontium was recently published (Kjällquist and Boethius 2026). Sampled areas included Denmark, Öland, Gotland and Götaland which constitutes the southernmost part of Sweden, extending towards the top of Lakes Vänern and Vättern. None of the bioavailable samples exceeded 0.740. The more negative $\delta^{18}O_c$ value for the older male suggests north but the differences are not substantial.

Discussion

None of the previously performed ^{14}C-dates on human bone from Mesolithic graves on Öland have been calibrated for marine reservoir effect (Table 1). All three bone elements in question should therefore be regarded as younger. How much younger depends on where the individuals collected the main part of their sustenance, linked to provenience and mobility for which strontium isotope analysis is useful. However, strontium isotope analysis has not been performed on either of these elements.

The osteological profiles present two male individuals, one mature adult and one subadult. The subadult individual displays several indications of pathology, some with idiopathic or congenital etiology. Both individuals have healed fractures and manifest various types of joint disease, and both display extensive entesophytes. These collective pathological traits reflect a strenuous lifestyle perhaps in combination with congenital malformations for individual 1049 and old age for individual 1050.

Dietary isotopic analyses of collagen indicated a high intake of marine proteins. When compared to other sites, both Mesolithic and Neolithic, differences in $\delta^{13}C$ and $\delta^{15}N$ were detectable (Figure 9). Kanaljorden and Strandvägen are two Mesolithic sites from Östergötland, Sweden; Vedbæk is a Mesolithic site from the northeastern part of Zealand, Skateholm located on the southernmost coast of Sweden and dates to the Late Mesolithic period; Huseby-Klev is a Mesolithic site in Bohuslän, Sweden; Frälsegården is a Neolithic megalith in central Västergötland; Västerbjers is a Neolithic settlement on Gotland, and Köpingsvik and Alby-Triberga are both Mesolithic settlements on Öland that are previously discussed in this study. The individuals from the double burial had similar but slightly lower nitrogen levels compared to the other Mesolithic individual from Alby-Triberga (L1958:6118). A total of five teeth and bones were sampled for nitrogen, presenting a span between 14.9-15.7 (mean 15.3) whereas the values for the

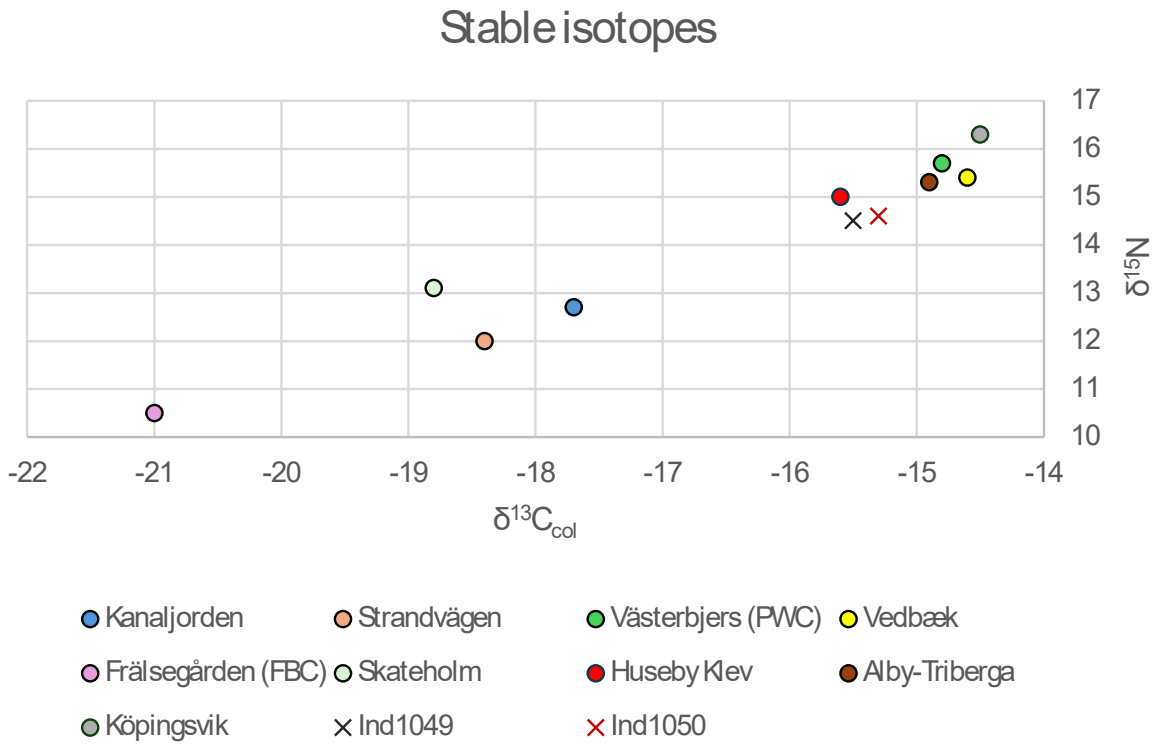


Figure 9. Biplot of mean δ13C and δ15N-isotopic values from Scandinavian hunter-gatherer-fisher sites and one Funnel beaker site (Frälsegården) in comparison with isotopic values for individuals 1049 and 1050, Data from: Sjögren and Price 2013; Eriksson 2004; Lidén *et al*. 2004; Eriksson *et al*. 2008; Eriksson *et al*. 2018 (Figure by Sandra Tornberg Fritz).

individuals in the double burial were 14.5 and 14.6, respectively. $\delta^{13}C$ values were slightly higher (-14.9 to -14.9) for the other Alby-Triberga individual, as well as for individuals from Vedbæk, Västerbjers and Köpingsvik, indicating a higher intake of marine mammals. As for individuals 1049 and 1050, along with mean values from Huseby Klev, results rather indicate a higher intake of marine fish. Other Mesolithic findings from Motala (Strandvägen and Kanaljorden) indicate intakes of freshwater fish. The data from Frälsegården instead provides an agricultural outline of an inland, grain-based diet. The $\delta^{13}C_{apatite}$ values of both individuals were -9.6‰ and -9.1‰ respectively. There are few previous studies presenting comparable material, however $\delta^{13}C_{apatite}$ was investigated in a PWC group in Gotland. The PWC group from Västerbjers was contemporary with Neolithic settlers but were hunter-gatherers. Zooarchaeological material from the Västerbjers site suggested a mixed-Neolithic economy where wild boar was the dominant food resource (72.6%) with an addition of seals (10.9%). Strontium isotope values from Västerbjers suggest that the PWC group was more sedentary than contemporary Neolithic populations in the same area. Stable isotope values from the PWC group displayed $\delta^{13}C_{apatite}$ values between -9.8 to -12.1‰. $\delta^{13}C_{collagen}$ values for the same site varied between -14.2 to -16.3‰ which coincides with the values for both individual 1049 (-15.5‰) and individual 1050 (-15.3‰). The difference in apatite $\delta^{13}C$ between the PWC group and individuals 1049 and 1050 indicate a comparably higher intake of both C3 and C4 source proteins and a lesser intake of C3 source carbohydrates and fats (Eerkens *et al*. 2013).

There are several remarkable factors concerning the double burial in Alby-Triberga. Given the island's limited area, several Mesolithic burials have been found, however this is the only known double burial. The grave contains two men that seemingly were buried simultaneously, they also appear to have been placed together, hand-in-hand. The isotopic analyses indicate coastal habitation and indicate that the mature individual had its provenance in an area with significantly older bedrock, possibly south-western Finland. The initial

handling and preservation of the remains is however unknown. It should be noted that even though there is no record of it, there is a potential risk of varnish contamination in the sample. Finland soils are unfortunately naturally acidic which directly affects the preservation of organic matter, no human skeletal remains from the Finnish Mesolithic period have been found.

Strontium studies of human mobility require some prior knowledge of background levels of the strontium isotope ratio. The data on $^{87}Sr/^{86}Sr$ ratios of biologically available strontium in the environment, widely used in ancient population mobility studies, is scarce and scattered for most of the north-eastern Baltic Sea Region. The closest high value in the Baltic Sea area can be seen in southwestern Finland, in the area around the Kokemäen river basin (Bataille *et al.* 2020; Danielisová *et al.* 2025; Löfvendahl *et al.* 1990; Price et al. 2021). High values have also been observed in central Sweden (Åberg *et al.* 1989). However, the values in question derive from bedrock and not bioavailable sources. Higher values are also to be expected in northern Norway and Sweden based on rock types. Comparable Mesolithic material with corresponding strontium isotope values have not been observed in either northern Norway or Sweden prior.

The Finnish Geological Survey has compiled strontium isotope ratios in bedrock along with many other chemical values in its Rock Geochemical Database (Price *et al.* 2018). Kaislaniemi (2011) described a range of values between 0.7135 and 0.7637 with a weighted average of 0.7293 for all of Finland. He noted that no systematic difference between Archaean and younger rocks can be seen in the estimated isotope ratios.

Price *et al.* (2021) includes new information on strontium isotope baselines in southern Finland. Archaeological samples of small mammals, mostly hare (*Lepus timidus* or *europaeus*) skeletal remains, were collected from southern Finland and measured for $^{87}Sr/^{86}Sr$. The goal was to develop a baseline for the local strontium isotope background. In general, the strontium isotopic baseline values in the region correlate with soil and bedrock geology and are characterized by values of 0.730 or greater, measured on modern animals, mostly hare (*Lepus timidus* or *europaeus*) skeletal remains. Another study by Danielisová *et al.* (2025) measured strontium isotopes on humans and fauna from the Medieval Luistari cemetery in southwestern Finland. Values generally ranged between 0.7245 and 0.7433.

Conclusion

In conclusion, the two individuals buried in the grave at Alby-Triberga may well have been related. This could also explain the burial placement of the two men holding hands. They have similar diets and the ages suggest they could be father and son. Their places of birth appear very different. The younger male seems to have been locally born while the older male is from a distant location. The exact location is impossible to determine, but appears to be to the north, perhaps in Finland. Recommended future investigations include genetic kinship between both individuals as well as between all Mesolithic individuals from Öland. Expanded isotopic analyses including ^{13}C, ^{15}N and $^{87}Sr/^{86}Sr$ for all Mesolithic individuals on the island could indicate dietary patterns, origin and better determine the dating regarding the marine reservoir effect. Additionally, further studies on bioavailable strontium isoscape mapping for central Sweden and Finland could help identify areas from where individual 1050 originates.

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Declaration of Interest Statement

The authors declare there are no conflicts of interest.

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