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RESEARCH ARTICLE

King Olaf's men? Contextualizing Viking burials at S:t Olofsholm, Gotland, Sweden

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Abstract

The discovery of burials at S:t Olofsholm, a site associated with the Saint Olaf cult on Gotland in Sweden, has enabled a bioarchaeological contextualization of medieval legends and sagas in conjunction with the archaeological record. This study seeks to illuminate who were buried at S:t Olofsholm, through a biocultural lens, and whether these burials can be linked to folklore and sagas associated with the site. Five burials of possibly six individuals (cal. AD 980–1270) were assessed macroscopically and through stable isotope analysis ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{34}\text{S}$, $^{87}\text{Sr}/^{86}\text{Sr}$, and $\delta^{18}\text{O}$) of incremental dentine, bulk enamel, and bone samples. Sagas and legends associated with S:t Olofsholm mention episodes of conflict and contact involving King Olaf Haraldsson of Norway (later canonized as Saint Olaf), Gutes and Icelanders, and travels between Norway and Kyiv Rus. Two (or three) burials show signs of violent deaths, including evidence of sharp force trauma and burning. Isotope analyses indicate local and non-local signals, with possible links to southern Scandinavia, Britain, Iceland, the Baltics, and Kyiv Rus. In general, the evidence neither challenges nor confirms the legends and sagas associated with S:t Olofsholm. Instead, the findings illustrate the site's function as an early Christian place of worship within a wider Viking world that was characterized by travel and contact across the Baltic Sea, Scandinavia, and beyond. The burials at S:t Olofsholm are likely to be non-normative as indicated by their place of interment and the violent cause of death of most individuals.

KEYWORDS

bioarchaeology, *Guta Saga*, *Heimskringla*, isotope analysis, Scandinavia

1 | INTRODUCTION

The cult of Saint Olaf (*St. Olave*) was one of the most popular and widespread expressions of Christian faith in Scandinavia during the medieval period. Olaf Haraldsson (born c. AD 995)—King of Norway

between AD 1015 and 1028—was killed at the Battle of Stiklestad on July 29 in AD 1030. Olaf's body was interred in Nidaros (Trondheim), which became one of the most significant pilgrimage destinations in Europe (Duda, 2016). Numerous churches and chapels across Scandinavia, as well as in the eastern Baltics, Novgorod, and on the British and Irish Isles, were dedicated to Saint Olaf (Dickins, 1937–1945; Jackson, 2010; Kvam, 1996; Markus, 2017). On

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the island of Gotland in the Baltic, the cult is most notably linked to a peninsula at Akergarn (57°42′59.39″N, 18°54′33.99″E) in Hellvi Parish, known as S:t Olofsholm (Eng. “Saint Olaf’s islet”) (Figure 1).

S:t Olofsholm is located adjacent to a natural harbor, which according to one of the traditions, is where Olaf and his men disembarked en route to Norway from Kyiv Rus in the spring of AD 1030 (Peel, 2019: 257–260). Olaf’s visit to Gotland is described in several sources, most notably the *Guta Saga* dating around the second half of the 13th century AD (Mitchell, 2014; Peel, 2019). As recounted in *Guta Saga*, Olaf and his men lay at the harbor in Akergarn for “a long time”, during which they met several “powerful men”, exchanged gifts, and brought Christianity to the Gutes (Gotlanders). One of these Gutes was Ormika from Hejnum, who gave Olaf 12 yearling rams and other valuables and received two drinking vessels and a battle-ax in return. Ormika is said to have received Christianity from Olaf and later had a chapel built at Akergarn (Peel, 2019: 279).

Contemporaneous to *Guta Saga* is *Heimskringla*, which is a collection of sagas penned by Snorri Sturluson (AD 1171–1241) at the beginning of the 13th century. According to Snorri in *Saint Ólaf’s Saga* (Sturluson, 2014 [c. AD 1230]), Olaf was on Gotland when he heard of the news that Norway was without a King and decided to return home. Snorri claimed that Olaf had visited Gotland previously when, in the autumn of AD 1007, he had participated in Viking raids across the Baltic Sea. During these raids, he laid Gotland to waste and took local tribute money. A similar narrative is given in the much later 17th-century work *Chronica Guthilandorum*—based on quasihistorical sources, ancient legends, sagas, and folklore—by the First

Superintendent of the Church (a similar rank to Bishop) Hans Nielson Strelow (1587–1656). Strelow stated that Olaf and his men were engaged in battle against (heathen) Gutes at Laikarhaid (see Figure 1), and that it was Olaf himself who built the chapel at Akergarn (Strelow, 1633:129–132).

1.1 | Archaeological excavations at S:t Olofsholm

The site of S:t Olofsholm in Akergarn is today a nature reserve area. It includes the visible footprint of a west–east-oriented rectangular chapel that also survives in part as a structure incorporated into a 19th century building standing on the site. The foundation and adjacent areas were excavated between 2013 and 2014. A first phase of construction was represented by an 11th century 14 × 10 m structure that may very well have been the original chapel that—according to *Guta Saga*—was erected by Ormika. This building was later replaced by a larger (c. 30 × 13 m) construction (Phase 2; c. AD 1100) that partly incorporated the older foundations (Carlsson, 2018). The archaeological excavation also revealed six burials mainly located immediately south of the chapel, including one cenotaph and four cists.

1.2 | Aims and objectives

In recent years, there has been increased interest in critical archaeological discourse relating to sites and remains associated with ancient

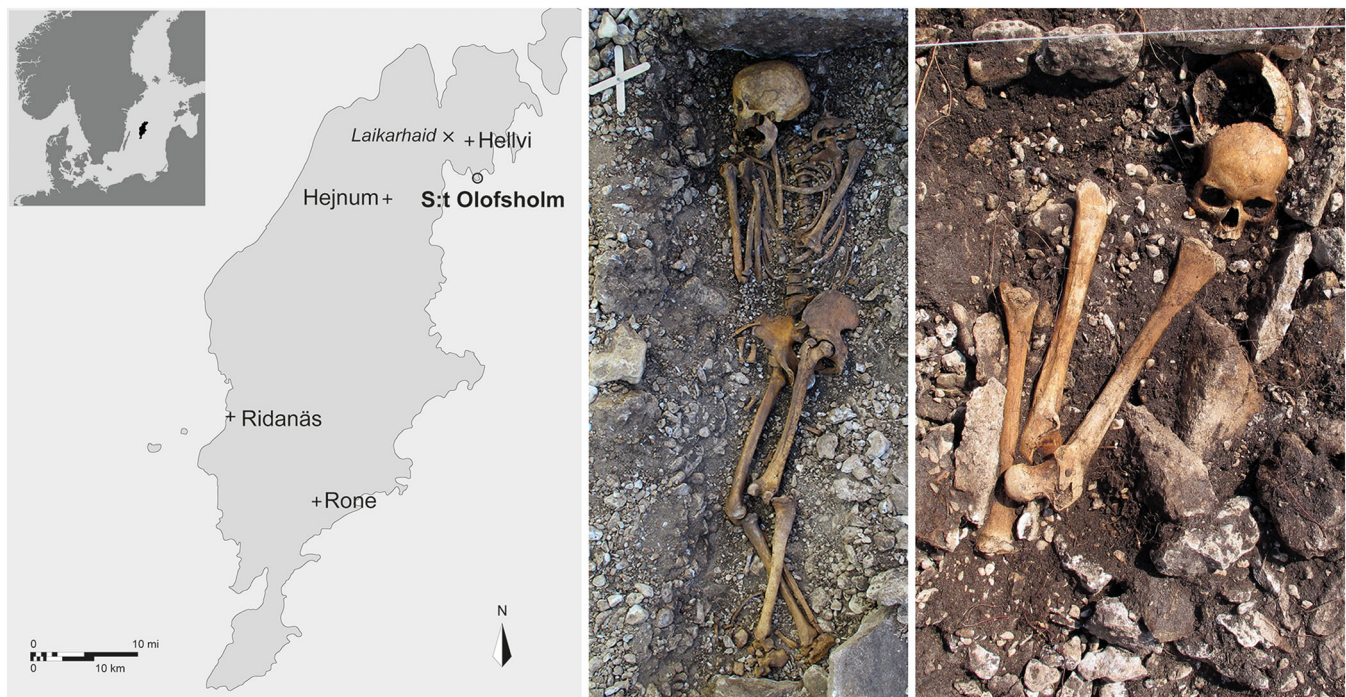


FIGURE 1 Map of Gotland (left) with geographical locations of places mentioned in the text; the skeletal remains of the older adult female 004-14 (middle) and parcel burial 003-14 (right) containing the cranium, femora, and a left tibia from possibly two individuals. Photos: Dan Carlsson. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

medieval myths, legends, and historical events (e.g., Price et al., 2019; Sten et al., 2016), in contrast to the nationalistic narratives that traditionally dominated research on this topic (cf. Gilchrist, 2020). While the legend of Saint Olaf was pivotal in forming a Norwegian national identity during the 19th century era of romantic nationalism (Falnes, 1968), historically, it has also been an instrumental narrative in constructing a cultural identity on Gotland (Sands, 2018). Considering the many layers of historical and cultural significance associated with S:t Olofsholm, the archaeological discoveries on the site allows for a dialog between folklore, ancient texts, material culture, and scientific (bioarchaeological) evidence.

This study seeks to determine whether the bioarchaeological evidence can shed light on accounts given in *Guta Saga*, *Heimskringla*, and later sources to elucidate who were interred at S:t Olofsholm. By assessing isotopic signatures of provenance through a biocultural contextualization (see Hakenbeck, 2013), the research aims to identify potentially local and/or non-local individuals in the sample. Furthermore, analyses of dietary indicators, and incremental data, reveal whether the individuals interred at S:t Olofsholm display varied or homogenous “life histories” in terms of diet, which provide further insight into possible migration patterns reflected as changing subsistence patterns during life.

2 | MATERIALS AND METHODS

Human skeletal remains were recovered from five burials. Radiocarbon dates suggest that they are all contemporaneous and calibrated dates fall within the range AD 980–1270 (see Table SI.1) The majority of the skeletons were well-preserved, virtually complete, and interred in a west–east orientation. The notable exception was parcel burial 003-14 (see Figure 1), which comprised a cranium and long bones from potentially two separate individuals (see below).

2.1 | Osteological analysis

Sex was determined from pelvic and cranial morphology (Sjøvold, 1988). Age-at-death was estimated from epiphyseal closure (Scheuer & Black, 2000), dental attrition (Lovejoy, 1985; Miles, 1962), cranial suture obliteration, and morphology of the auricular surface and pubic symphyses of the coxal bones and other skeletal features using the transition analysis method (Baldsen et al., 2002; ADBOU [TA3] Version 0.8.5).

2.2 | Stable isotope analysis

Dental enamel was sampled from five teeth of four individuals for investigation of provenance through stable isotopes. Where available, bone collagen from a rib and a femur, along with tooth dentine increments, were analyzed. A total of five femur samples, three rib samples, and three teeth from four individuals were selected for dietary

analysis. Diets were modeled using the Bayesian mixing modeling FRUITS (Version 3.1) (see Fernandes et al., 2014). Stable isotope ratios of faunal remains ($n = 6$, see Table SI.2) excavated from S:t Olofsholm were measured for the purpose of incorporating into Bayesian mixing models as food source isotope data (Fernandes et al., 2014). As the faunal inventory was restricted, isotope data for other potential food sources were drawn from published studies of contemporaneous sites on Gotland. See Supplementary Information S1 for further details on sampling, pre-treatment, collagen extraction, and measurements.

2.2.1 | Investigating mobility

Strontium ($^{87}\text{Sr}/^{86}\text{Sr}$) and oxygen ($\delta^{18}\text{O}$, $^{18}\text{O}/^{16}\text{O}$) stable isotope ratios of human bioapatite or hydroxyapatite are widely used in bioarchaeological migration studies (e.g., Bataille et al., 2021; Price et al., 1994; White et al., 1998). Strontium, which is an alkali earth metal-like calcium, is incorporated into human bioapatite in small quantities and is derived both from foods consumed and from drinking water. The isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) of this bioavailable strontium vary spatially, corresponding to geological or bedrock values (see Bentley, 2006). Oxygen stable isotope ratios of skeletal tissues may also be used as an additional proxy for mobility in archaeological populations (Evans et al., 2006). As the $\delta^{18}\text{O}$ of human hydroxyapatite (the inorganic component of teeth) corresponds to drinking water $\delta^{18}\text{O}$ (which varies geospatially), enamel $\delta^{18}\text{O}$ can indicate childhood residence (see Pederzani & Britton, 2019).

Tooth enamel, rather than bone apatite, is generally preferred for $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{18}\text{O}$ analyses, as bone apatite is less resistant to diagenetic alteration and elemental exchange between sample and deposition environment than enamel (Pederzani & Britton, 2019; Slovak & Paytan, 2012). Unlike many other tissues, enamel is “fixed” at completion of tooth development and does not remodel during lifetime. It, therefore, provides a record of the stable isotope signal corresponding to childhood residential location. Sampling of teeth that develop at different ages can indicate mobility during childhood. Differences between the stable isotope values of tooth enamel and “local” burial context/locale values may point to mobility during adulthood (Evans et al., 2006). As sulfur stable isotope ratios ($\delta^{34}\text{S}$) in consumer tissues reflect sulfur source with little fractionation, they may also indicate residential mobility. For example, consumer $\delta^{34}\text{S}$ above the typical range of terrestrial food webs (i.e., >14‰) is typically taken to indicate consumption of marine resources and/or coastal residence (Nehlich, 2015: 10–11; Richards et al., 2001).

2.2.2 | Reconstructing diet

Co-analysis of the carbon ($\delta^{13}\text{C}$, $^{13}\text{C}/^{12}\text{C}$) and nitrogen ($\delta^{15}\text{N}$, $^{15}\text{N}/^{14}\text{N}$) stable isotope ratios of human tissue is a long-standing, widely employed tool used to reconstruct the diets of archaeological populations (DeNiro & Schoeninger, 1983; Schoeninger, 2010). The

method is based on the principle that foods consumed are reflected in the chemistry of human tissues. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of bone collagen or tooth dentine in skeletal remains provide a measure of dietary intake over a person's lifetime (Lamb et al., 2014). In rare instances, diet, and therefore $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, can also identify non-locals in archaeological populations (e.g., Pickard et al., 2017; Richards et al., 1998).

Sulfur stable isotope ratios ($\delta^{34}\text{S}$, $^{34}\text{S}/^{32}\text{S}$) have been included in some studies as a third dietary discriminant (see Bonsall et al., 2015; Nehlich et al., 2010). The $\delta^{34}\text{S}$ of plant and animal tissues directly reflects that of their sulfur source. In terrestrial food webs, the primary sulfur sources are local bedrock and aerosols. Bioavailable $\delta^{34}\text{S}$ in inland terrestrial systems, including those of the Circum-Baltic region, typically range from c. 1‰ to 10‰ (e.g., Nehlich, 2015; Peterson & Fry, 1987; Thode, 1991). In contrast, foods from marine systems typically have distinct $\delta^{34}\text{S}$ that range from c. 15‰ to 20‰, reflecting oceanic $\delta^{34}\text{S}$, which is c. 21.0‰ (Nehlich, 2015; Thode, 1991). Sea spray may result in the transfer of oceanic sulfate to nearshore regions, causing ^{34}S -enrichment in plants and associated food webs (Nehlich, 2015; Nielsen, 1974). Foods from freshwater systems have highly variable $\delta^{34}\text{S}$, ranging from -20.0% to $+20.0\%$ (Krouse, 1980; Nehlich, 2015; Thode, 1991).

Bone collagen remodels throughout life; however, the collagen turnover rate is variable in different skeletal elements. Rib collagen indicates average dietary intake over 2–5 years prior to death (Lamb et al., 2014), while collagen from the cortical portion of the femur records average diet over a much longer period, likely from adolescence up to death, although it may disproportionately reflect adolescent diet (Matsubayashi & Tayasu, 2019; Tsutaya & Yoneda, 2013; Ubelaker & Parra, 2011). Primary dentine develops incrementally from crown to root, is fixed at development, and does not remodel. Tooth dentine stable isotope ratios, therefore, reflect diet during childhood (Beaumont & Montgomery, 2015).

3 | RESULTS

S:t Olofsholm was a place of pilgrimage from at least around AD 1240 (Pernler, 1979). One of the few records that mention the chapel is a letter dating to AD 1367 in which the Bishop Nils Hermansson (AD 1325/26–1391) is recorded to have reinstated earlier decisions by his predecessor that responsibility for the upkeep of the chapel fell to Hellvi Parish and its priest (Pernler, 1979). In the summer of 1536, the chapel was raided, and several valuables were stolen (Siltberg, 1997), which suggest that it was still in use at that time. Local folklore associated with the site also contributed to making it a destination for visitors even after the Reformation. One famous visitor to the site in July 1741, the eminent Swedish botanist Carl Linnaeus (1707–1778), described what remained of the—by that time—ruined chapel and was shown “Saint Olaf's wash-basin” (Åsberg & Stearn, 1973), a natural rock formation where Olaf is said to have baptized the Gutes. It is not known exactly when the chapel at S:t Olofsholm went out of use. A map from 1694 annotates the location of a

ruined building on the place with “*gammel kyrkia öde*” (Eng. “old church deserted”) (Schilder, 1694), and it is described as “[...] *nu øde|nogett aff Murener siunlig*” (Eng. “now deserted|some of the walls are visible”) in Strelow's account from 1633 (Strelow, 1633: 132). Prior to the excavation, there was no recorded evidence of burials having taken place on the site.

3.1 | Burial morphology, demography, and paleopathology

The excavated burials were all located south of the chapel, or alongside the southern wall of its footprint, with one notable exception. The remains of an older adult female ($\bar{x} = 81.4 \pm 8.2$ years; 95% confidence interval [CI] [63.5, 98.2]) were interred in a cist in the southeast corner of the chapel (see Figure 1). As expected of an individual of an advanced age, the skeleton was osteopenic with severe dental attrition. In addition, there was extensive degenerative joint disease and osteoarthritis of the neck, spine, lower back, a hand, left knee, and both ankles. Another burial of interest was the aforementioned parcel burial 003-14—a redeposition of human remains (see Figure 1)—that contained a cranium, a left and a right femur, and a left tibia. The cranial sutures were open, and the eruption and wear of the available teeth suggested an age-at-death of 18–20 years. The long bones exhibited active epiphyseal fusion, indicating an age-at-death between 15 and 18 years.

Two burials display evidence of interpersonal violence, manifested both as antemortem and perimortem lesions. Skeleton 005-14, a middle adult male ($\bar{x} = 35.5 \pm 8.6$ years; 95% CI [23.6, 47.6]) interred partly below (and therefore predating) the southern wall of the Phase 1 chapel, exhibited unhealed sharp-force trauma affecting the right side of the skull. A cut has struck through the cranial vault across the parietal bone, from the level of the temporal line, in a superoinferior direction. Furthermore, a second cut is located across the face, striking through the inferior margin of the right zygomatic and penetrating c. 6 mm into the posterior portion of the right mandibular body while cutting through the lower canine and posterior teeth. Additionally, this skeleton exhibited a shallow oval depression just superior of the left orbit on the frontal bone that is indicative of healed blunt force trauma (Figure 2).

Skeleton 006-14, a middle adult male ($\bar{x} = 43.6 \pm 8.6$ years; 95% CI [28.0, 59.3]), displayed multiple indicators of unhealed sharp-force trauma, including a penetrating injury. A coronal cut, through the distal end of the right radius and ulna, has struck the right wrist and hand with the lower arm in supination. A second cut struck in a lateral superoinferior direction through the posterior of the right knee. Furthermore, a third cut is present through the right ankle and foot. Additionally, two shallow cuts—one through the posterior of the left shoulder and a second through the posterior of the left knee—are ambiguous because of post-mortem damage. The most striking violence-related injury in this skeleton, however, was the tip of an iron projectile embedded in situ in the body of the second thoracic vertebra. The projectile has penetrated through the bone laterally in a 45°

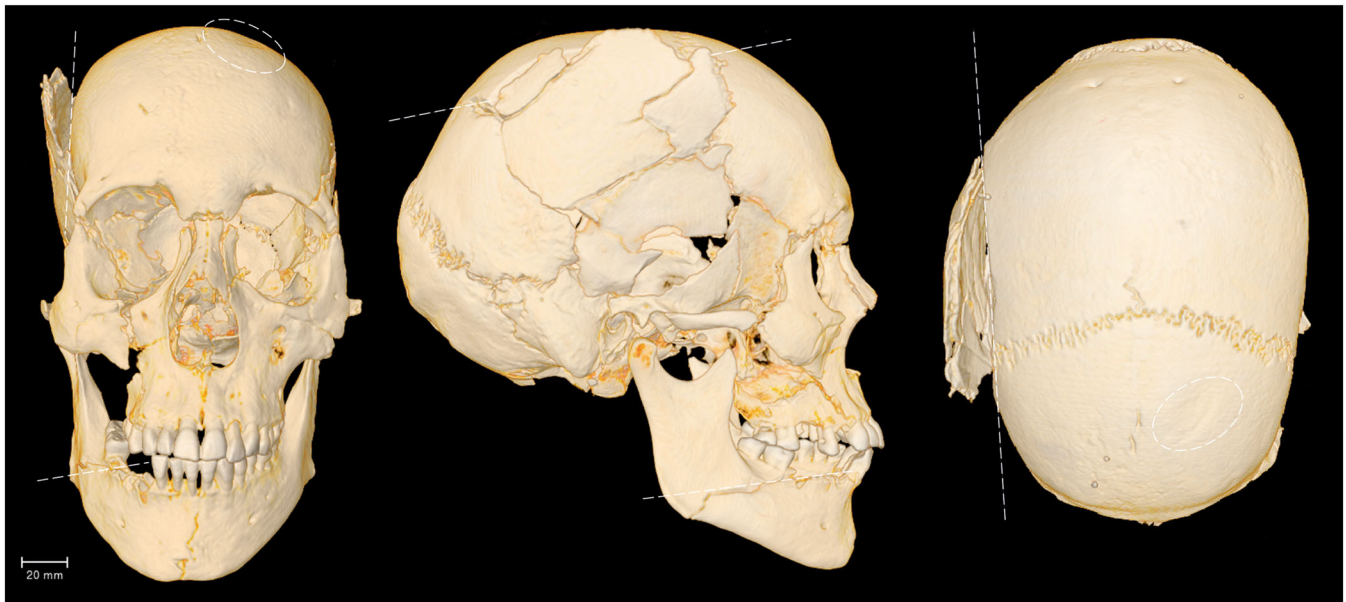


FIGURE 2 Computerized tomography images of the anterior (left) and right lateral (middle) and superior (right) aspects of the skull of middle adult male 005-15, with the location of cuts due to sharp-force trauma (dotted line) and antemortem blunt-force trauma (dotted oval). The skull was reconstructed temporarily from fragments prior to being scanned and displays some post-depositional distortion. Image: Gülçin Coşkun. [Colour figure can be viewed at wileyonlinelibrary.com]

superior–inferior angle on the left side and terminated about halfway through the vertebral foramen (Figure 3).

In addition to the two aforementioned cases, a possible violent death is represented by the truncated skeleton of a middle adult male ($\bar{x} = 43.0 \pm 9.0$ years; 95% CI [26.6, 59.6]), comprising the lower arms, hands, three lumbar vertebrae, pelvis, and lower limb elements. The skeleton, interred supine and extended in a cist with the arms and hands placed alongside the body, displayed large patches of black to dark gray charring on the posterior surface of the right proximal ulna, the lumbar vertebrae, and the pelvis, including the sacroiliac joints, the pelvic surface of the first sacral segment, and on the left iliac blade. Considering the position of the elements in the grave, the charring would suggest that the body was burnt prior to burial, but only to the extent that soft tissue still covered the bones (cf. Coty et al., 2018), and that fire exposure occurred perimortem. As the charring is most evident on the posterior of the skeleton, a likely scenario is that the body was lying face down. This would suggest that the individual was incapacitated when exposed to fire.

3.2 | Provenance

The $^{87}\text{Sr}/^{86}\text{Sr}$ and carbonate and phosphate $\delta^{18}\text{O}_{\text{VSMOW}}$ values of the individuals interred at S:t Olofsholm are listed in Table 1. Bioavailable $^{87}\text{Sr}/^{86}\text{Sr}$ on Gotland ranges from 0.7098 to 0.7128 (Ahlström & Price, 2021:5), and three of the four individuals analyzed had enamel strontium isotope ratios that fall within these values (Figure 4). Middle adult male 006-14, for whom two teeth were analyzed, had different $^{87}\text{Sr}/^{86}\text{Sr}$ for the first and second left mandibular molars (0.712762

vs. 0.711650). Although both values are within the local range, the $^{87}\text{Sr}/^{86}\text{Sr}$ for the earlier developing first molar sits on the upper limit of the local values. This may indicate movement during childhood between the ages of 4 and 9 years (AlQahtani et al., 2010), but whether this occurred within or from outside Gotland cannot be determined. Notably, the impact of maternal strontium on the first molar is a confounding factor here. While $^{87}\text{Sr}/^{86}\text{Sr}$ suggests that the three males analyzed were possibly from Gotland, it does not confirm provenance; one of the key limitations of strontium stable isotope analyses is equifinality, and these individuals could potentially have come from another region with similar geology and bioavailable strontium including much of the rest of Scandinavia (Price & Gestsdóttir, 2014–2018; Price & Naumann, 2014).

The $\delta^{18}\text{O}_{\text{PO}_4}$ data from the individuals at S:t Olofsholm range from 12.6‰ to 16.1‰. To the authors' knowledge, there are no published $\delta^{18}\text{O}_{\text{PO}_4}$ for archaeological populations from Gotland, that is, there are no comparanda. For this reason, and in spite of the large errors associated with this approach, $\delta^{18}\text{O}_{\text{PO}_4}$ were, therefore, converted to drinking water $\delta^{18}\text{O}_{\text{dw}}$ using Chenery et al.'s (2011) equation. The converted values show a broad range and for the cranium in parcel burial 001-13 suggest residence in a more northern region of Scandinavia or possibly central Europe, while the values of the other two males (005-14; 006-14) suggest childhood residence in a warmer region than Gotland. While $\delta^{18}\text{O}$ may indicate provenance, interpretation of archaeological $\delta^{18}\text{O}_{\text{PO}_4}$ is complicated by a number of “unknowables”. These include the possible consumption of imported resources, which may obscure local signatures, and also the brewing, stewing, or boiling of foods and drink, each of which can result in ^{18}O -enrichment (Brettell et al., 2012). Importantly, enamel $\delta^{18}\text{O}$ of



FIGURE 3 The skeletal remains of middle adult male 006-14, with evidence of perimortem sharp-force trauma and penetrating injuries: (a) in situ photograph; (b)–(c) iron projectile embedded into the second thoracic vertebra; sharp-force coronal cuts through the (d) wrist and palm of the right hand; (e) the posterior of the right knee; and (f) the postero-lateral aspect of the right ankle and foot. Photos: Dan Carlsson, Jonny Geber. [Colour figure can be viewed at wileyonlinelibrary.com]

teeth that develop from infancy may be impacted by a nursing signal (Knudson, 2009), and this may account, at least in part, for the variation evident in the $\delta^{18}\text{O}$ values.

In terms of the provenance analysis, the most interesting burial among the group is the older adult female 004-14. The strontium value measured from her left mandibular canine tooth lies well outside the local range for Gotland (see Figure 4), which indicates that she did not grow up on the island between the ages of c. 2 and 6 years (AlQahtani et al., 2010). It is non-trivial, however, to identify provenance precisely. Price and Gestsdóttir's (2014–2018) analysis of

medieval Icelandic populations established local $^{87}\text{Sr}/^{86}\text{Sr}$ of between 0.7055 and 0.7092, and notably, those individuals interred in the coastal cemetery at Haffjarðarey had a mean $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.7086 ± 0.0005 . While this data may suggest a possible Icelandic origin for 004-14, there are several other locations with $^{87}\text{Sr}/^{86}\text{Sr}$ values in this range. These include south Norway, Denmark, and Scania in the south of Sweden, parts of Britain, as well as regions of the North European Plain, which would include the historical region of Kyiv Rus (Åberg et al., 1998; Evans et al., 2012; Frei & Price, 2012; Price & Gestsdóttir, 2014–2018).

TABLE 1 Enamel strontium ($^{87}\text{Sr}/^{86}\text{Sr}$), carbonate oxygen ($\delta^{18}\text{O}_{\text{CO}_3}$), phosphate oxygen ($\delta^{18}\text{O}_{\text{PO}_4}$), and bioapatite carbon ($\delta^{13}\text{C}_{\text{CO}_3}$) stable isotope ratios. Mean drinking water ($\delta^{18}\text{O}_{\text{dw}}$) values were calculated from $\delta^{18}\text{O}_{\text{PO}_4}$.

Burial	Age	Sex	Sample ^a	$^{87}\text{Sr}/^{86}\text{Sr}$	$\delta^{13}\text{C}_{\text{CO}_3}$	$\delta^{18}\text{O}_{\text{smow CO}_3}$	$\delta^{18}\text{O}_{\text{smow PO}_4}$	$\delta^{18}\text{O}_{\text{dw}}$
003-14	AO	M	FDI15	0.711531	-13.13	21.56	12.63	-16.12
004-14	OAd	F	FDI33	0.708576	-15.15	22.83	13.87	-13.42
005-14	MAd	M	FDI36	0.711267	-13.87	24.29	15.31	-10.30
006-14	MAd	M	FDI36	0.712762	-14.80	25.12	16.11	-8.54
			FDI37	0.711650	-13.53	24.18	15.19	-10.54

Abbreviations: AO, adolescent (12–20 years); F, female; M, male; MAd, middle adult (35–50 years); OAd, older adult (50+ years).

^aNotation: Fédération Dentaire Internationale (FDI), 1971.

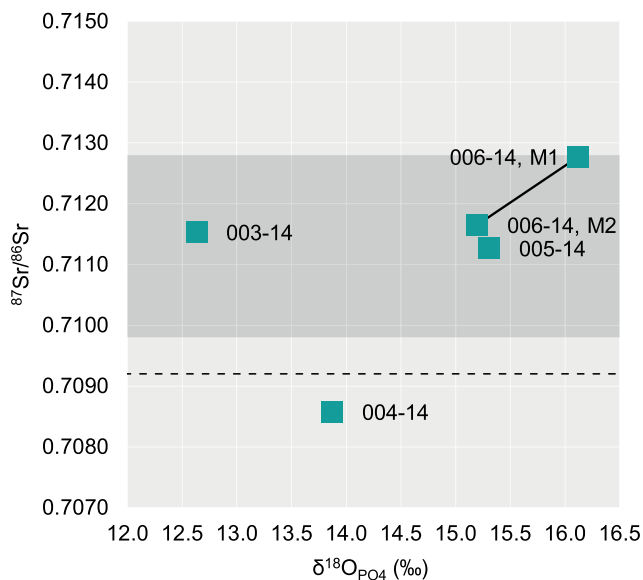


FIGURE 4 Scatterplot of $\delta^{18}\text{O}_{\text{PO}_4}$ vs $^{87}\text{Sr}/^{86}\text{Sr}$. The shaded area indicates the terrestrial $^{87}\text{Sr}/^{86}\text{Sr}$ baseline for Gotland (from Ahlström & Price, 2021). The $^{87}\text{Sr}/^{86}\text{Sr}$ value of seawater (0.7092) is shown by the dotted line. Note: The $^{87}\text{Sr}/^{86}\text{Sr}$ measurement error is 0.000009 (2σ). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

3.3 | Dietary “life” histories

Spatiotemporal variation in food source isotope values necessitates the use of local, contemporary values as baselines for dietary models. Domesticates from S:t Olofsholm had carbon and nitrogen stable isotope ratios typical of animals grazing or browsing on a north-west European terrestrial C3 biome (with $\delta^{13}\text{C}$ ranging from -20.6‰ to -22.4‰ and $\delta^{15}\text{N}$ from 6.5‰ to 10.0‰). Carbon isotope ratios of animals from the prehistoric sites of Ire and Västerbjers point to C3 graze/browse being the mainstay of Gotland's domesticates and wild animals (see Eriksson, 2004; Kosiba et al., 2007). Isotope signatures of domesticates from Viking and early Christian Ridånäs (Kosiba et al., 2007) are distinct. While nitrogen isotope ratios were similar to those from S:t Olofsholm (from 6.3‰ to 8.2‰), the carbon isotope ratios range from -17.0‰ to -16.1‰. Although only three

domesticate samples from Ridånäs were measured (one cattle, one sheep, and one pig), the relatively high $\delta^{13}\text{C}$ of these animals point to the inclusion of marine resources in their diets. While consumption of C4 plants such as millets can also result in ^{13}C enrichment, the use of C4 fodder is considered unlikely in medieval Gotland (see Kosiba et al., 2007 for discussion). Kosiba et al. (2007) proposed that supplementation with fishmeal could account for the high carbon isotope ratios evident in the Ridånäs domesticates; an alternative explanation is restricted grazing on coastal seaweeds and algae (e.g., Blanz et al., 2020).

Bone collagen $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$ ranges (Figure 5; Table SI.3) suggest a non-homogenous diet within the S:t Olofsholm group (see Lovell et al., 1986). Femoral bone collagen stable isotope ratios were used to model the “adult” diet, and estimates of the relative calorie contributions of different foods are shown in Table 2 and Figure SI.1. Mean estimates of food source contribution point to calories having been largely derived from terrestrial food sources, that is, cereals and domesticate meat and dairy. The models suggest that diets varied among individuals. Middle adult male 001-13 had a diet overwhelmingly dominated by cereals; while others likely consumed a larger proportion of domesticate meat and/or dairy produce. The older adult female 004-14, who has both the highest $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, may have derived a higher proportion of their average diet from marine foods than other individuals analyzed (see Table 2); however, the credible interval indicates that individual differences in consumption of marine resources may have been minimal and overall, the contribution of fish to the dietary calories of the individual interred at S:t Olofsholm was low. The modeled proportion of dietary protein derived from fish and sea mammals was somewhat higher (Figure SI.1), and this is perhaps unsurprising given the relatively high protein concentration of fish and sea mammals in comparison with cereals.

3.3.1 | Incremental dentine

Incremental samples of dentine were measured for $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$ for three of the four individuals with available dentitions from S:t Olofsholm (Figure 6; Table SI.4). The dentine of older adult female 004-14 was not well-enough preserved for analysis. The dentine

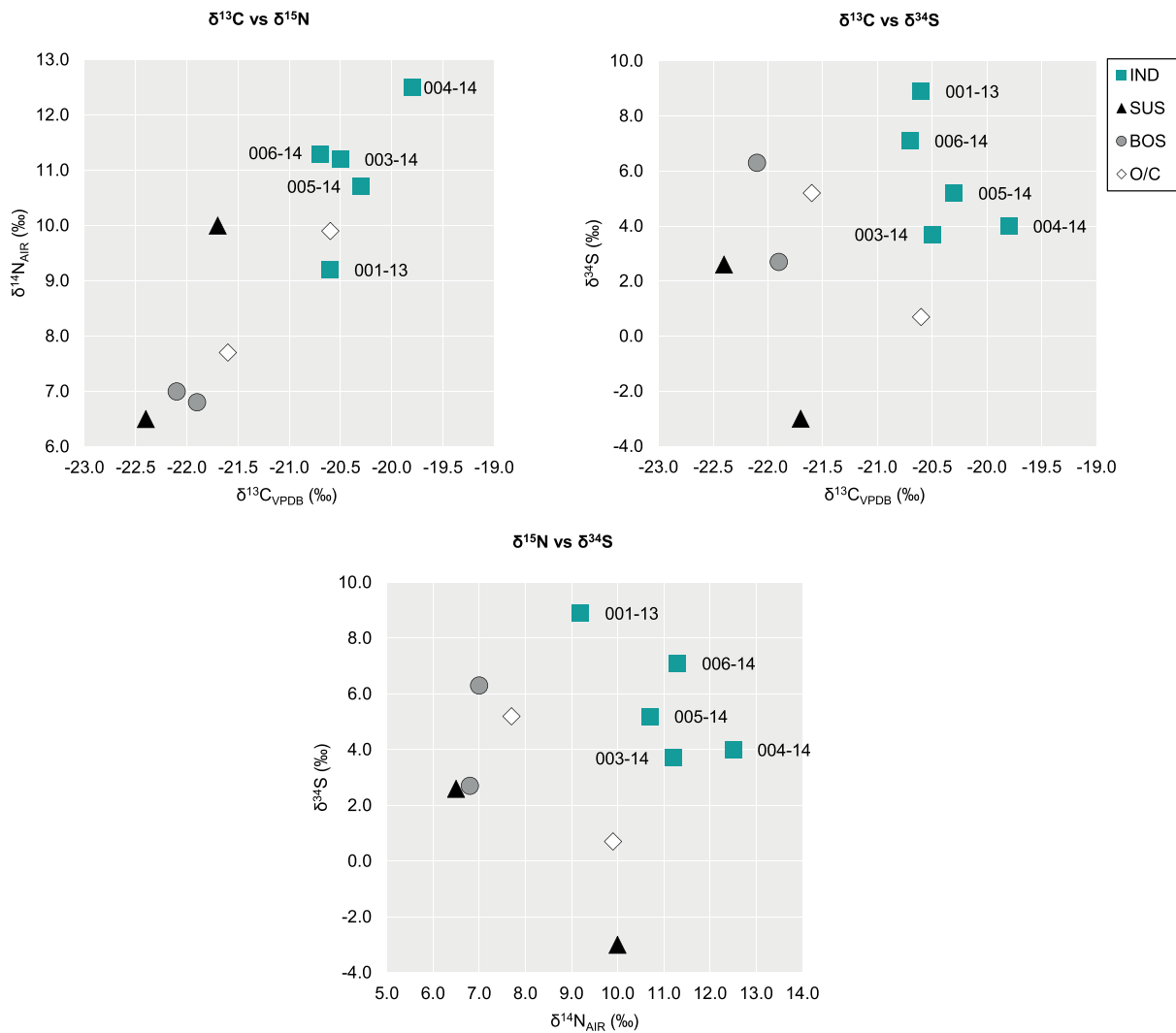


FIGURE 5 Scatterplot of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$ values of femoral bone collagen from the individuals buried at S:t Olofsholm. Stable isotope values of faunal remains are included to provide baseline data. Abbreviations: BOS, cattle; IND, individual; O/C, caprovine; SUS, pig. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/oa.3211)]

TABLE 2 Estimates of food source contribution to whole diet (mean estimates and standard deviation in %calories derived from FRUITS).

Burial	Age	Sex	Cereal contribution (%)	Domesticate contribution (%)	Freshwater fish contribution (%)	Marine contribution (%)
001-13	MAd	M	92 ± 8	7 ± 8	1 ± 1	2 ± 2
003-14	AO	M	79 ± 12	17 ± 12	2 ± 2	2 ± 2
004-14	OAd	F	71 ± 13	22 ± 13	4 ± 3	3 ± 3
005-15	MAd	M	85 ± 11	12 ± 11	2 ± 2	2 ± 2
006-16	MAd	M	79 ± 13	16 ± 13	2 ± 2	2 ± 2

Abbreviations: AO, adolescent (12–20 years); F, female; FRUITS, Food Reconstruction Using Isotopic Transferred Signals; M, male; MAd, middle adult (35–50 years); OAd, older adult (50 + years).

$\delta^{34}\text{S}$ values range from -0.8‰ to 7.1‰ . This is within the range of $\delta^{34}\text{S}$ of terrestrial herbivores (-3.2‰ to 11.8‰) from medieval sites across Circum-Baltic region (Bataille et al., 2021). The most homogeneous $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were observed in middle adult male 006-15, which suggests a relatively uniform diet with little variation

(at least isotopically) throughout life. In contrast, the dentine $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of the individual represented by the cranium in the parcel burial 003-14 show a sharp increase in both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ between the ages of approximately 10 and 18 years. This points to higher consumption of marine resources during the later period of dentine

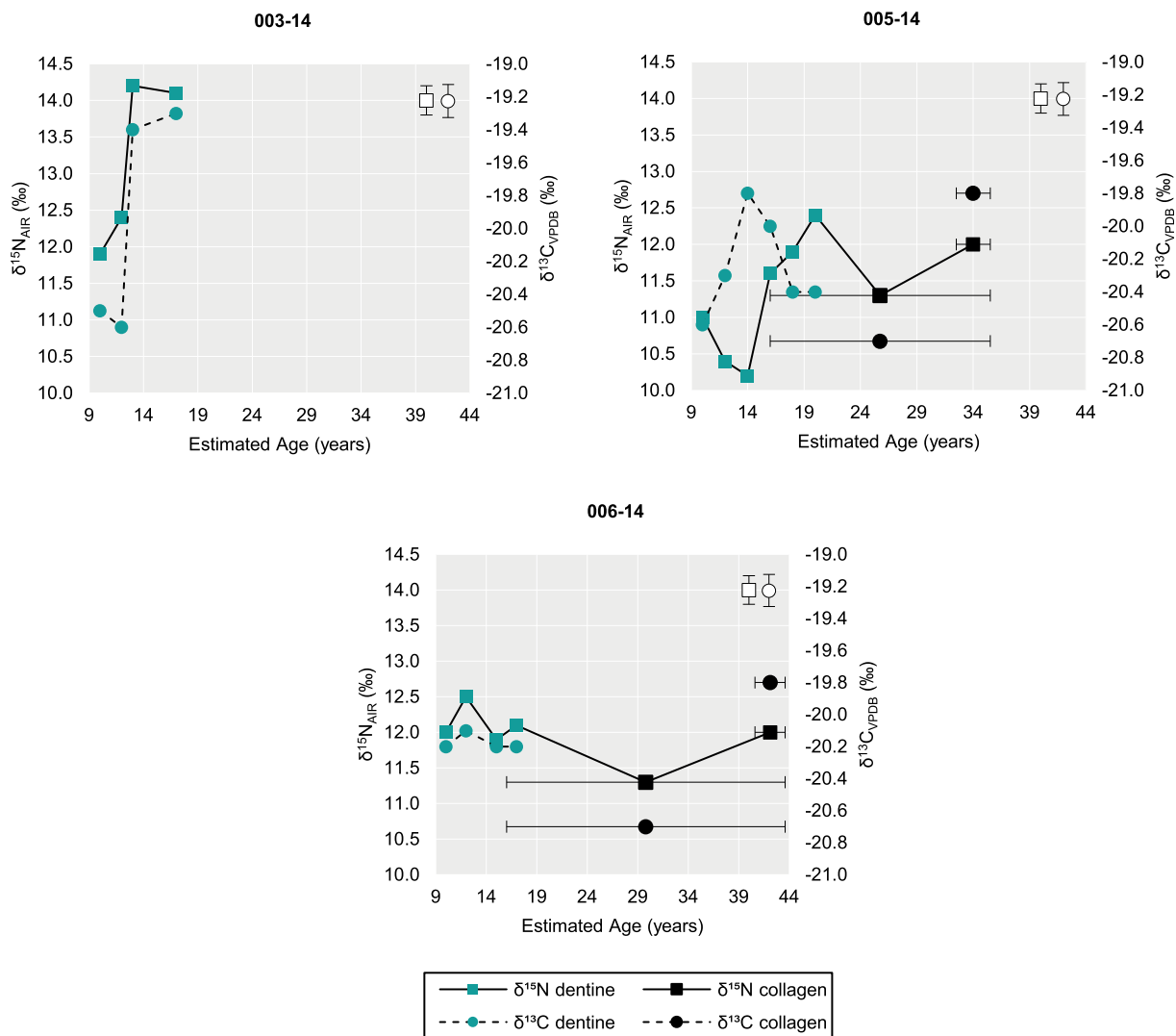


FIGURE 6 Dietary “life histories” of the S:t Olofsholm individuals. Collagen $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ taken from sequential dentine increments, femur, and rib bones. Horizontal bars on rib and femur data indicate average dietary timespan. Vertical error bars indicate instrumentation measurement error ($\delta^{13}\text{C}$ measurement error = $\pm 0.1\%$; δN measurement error = $\pm 0.2\%$). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/oa.3211)]

formation, a dietary shift that is not evident in the other individuals sampled from S:t Olofsholm. Many different scenarios could be proposed to account for this difference, including movement between sites or regions with varying dependence of marine foods, individual dietary preference, and seasonal scarcity resulting in episodic reliance on coastal resources, and differential access through activities (e.g., fishing).

Inverse correlation of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ is evident in middle adult male 005-14 during later childhood and may point to catabolism, an indication of physiological stress (Crowder et al., 2019). This possibility is suggested cautiously, however, for two reasons: first, the relatively long timespans represented by the dentinal increments, which may obscure shorter-term trends and second, clinical studies suggest that catabolism has less influence on the isotope signatures of bone collagen than on other tissues such as bone apatite (Canterbury et al., 2020).

4 | DISCUSSION

Among the cultural expressions of Viking society was a tradition of folklore, storytelling, myths, and legends of which the ancient narratives of Saint Olaf were part. In addition to the chapel at S:t Olofsholm, at least five other churches on Gotland were dedicated to Saint Olaf (Kvam, 1996). In addition to these, the parish church in Rone in the southern part of the island has a mid-14th century stone relief with a motif of two people in a boat embedded into the surround of a portal in the church tower (Lagerlöf & Stolt, 1973:367–368). The relief depicts a man with an ax and a presumed woman in a wimple (see *ibid.*: Figure 418). The woman holds a drinking vessel, and the depiction has been interpreted as Saint Botvid of Sweden and a woman servant. An alternative interpretation is that the relief illustrates Saint Olaf exchanging gifts with Ormika, as mentioned in the *Guta Saga* (Sjöstrand, 2018).

The possibility that Ormika was a woman is interesting in the context of this study. In Strelow's account of Saint Olaf and the conversion of the Gutes, he refers to Ormika (which, from its diminutive suffix can be interpreted as a feminine form) with female pronouns (Strelow, 1633:132). If Strelow is correct, it is tantalizing to suggest that older adult female 004-14, interred within the chapel at S:t Olofsholm, is that of Ormika and that this particular grave signifies a status placement given to the individual responsible for erecting the chapel. According to *Guta Saga*, Ormika resided in Hejnum and was a Gute. The female interred inside the chapel, however, did not spend their early childhood on Gotland. While this fact in itself would not contradict the possibility that Ormika and the older female buried at S:t Olofsholm are one and the same, the bioarchaeological evidence cannot provide any proof. However, should the remains indeed be those of Ormika, social and cultural identity as Gute may not have been determined from origin at birth or childhood but rather the social position achieved later in life (cf. Margaryan et al., 2020).

Strelow's account of the conversion of the Gutes is relevant in relation to the violent deaths evident in the S:t Olofsholm burials. Whether the aforementioned Battle at Laikarhaid was a factual event or not cannot be ascertained, but Strelow's narrative of violence linked to Olaf's visit(s) to Gotland fits well with the burials at S:t Olofsholm, where the bioarchaeological evidence clearly attests to conflict and skirmishes having taken place. The findings give further weight to the myths and legends associated with Saint Olaf on Gotland. Violence is featured in Snorri's account in *Heimskringla*, which includes the story of an Icelander named Jökull Bárðrson, who together with some other men had stolen ships, including Olaf's own vessel Visundr (the Bison) (ibid.: 222):

[...] Jökull came up against King Óláfr's troops in Gotland and was captured, and the king had him taken to be executed, and a twig was twisted in his hair and a man held it. Jökull sat on a sort of bank. Then a man tried to behead him. But when he heard the whistle of the axe, he straightened up, and the blow landed on his head, and it was a deep wound. The king saw that it was a death wound. The king then told them to leave him be.

Being mortally wounded, but still in vigor and in true Viking manner, Jökull sat up and versed just before he died (ibid.):

Wounds smart with weariness; I was often suited better. An injury is on me that spurted eager crimson liquid. My gore gushed out of this gash. I get used to endurance. The honoured helm-noble ruler hurls his anger at me.

This narrative is an interesting analogy to the pattern of violence seen in the burials at S:t Olofsholm, and burial 005-14 in particular, which exhibited deep sharp-force trauma through the right side of the skull. The likelihood of surviving such an injury, even temporarily,

however, does not seem probable. Furthermore, the strontium values from the dental enamel of this individual suggest that he was not born in Iceland. Nevertheless, the narrative of Jökull's death and the trauma of burial 005-14 both capture the characteristic violence and death that were present in Norse and Viking societies across Scandinavia and beyond (cf. Jensen, 2017; Kousoulis et al., 2016; Loe et al., 2014).

4.1 | Who were buried at S:t Olofsholm?

Even though the bioarchaeological evidence from S:t Olofsholm and medieval (and later) sources relating to the site cannot be perfectly aligned, the burial morphology and results of the scientific analyses are intriguing. All the available evidence suggests that the site functioned as a place of pilgrimage, while the parish church at Hellvi provide for the religious and spiritual needs of the local parishioners, including burial. It, therefore, seems likely that the interments at S:t Olofsholm were distinct, both in terms of where they were placed and possibly also in relation to the particular circumstances surrounding their deaths; although only a small number of burials have been studied from S:t Olofsholm, the ratio of violent deaths is exceptionally high (cf. Baten et al., 2021).

While the strontium and oxygen stable isotope ratios cannot pinpoint the exact origin of the individuals interred at S:t Olofsholm, the data nevertheless indicate that the males are of possible local (to Gotland) origin, while the only female in the group resided outside the island of Gotland during early childhood. Further potential migration patterns are also evident from the incremental dentine data. All three assessable individuals exhibit dietary shifts, initially—somewhat expected—in late childhood (cf. Naumann, Douglas, & Richards, 2014) and a further shift between late childhood and late middle adulthood. Considering accounts of widespread travel across the Baltic and wider Scandinavia, as indicated in *Guta Saga* and other sources, these dietary patterns should perhaps be viewed as a reflection of Viking lifeways; shifts in diet were a natural indication of cultural adaptation and varied experiences throughout life.

This potential notion of sociocultural intricacy can be further supported from the results of the analyses undertaken in this study. While the small group interred at S:t Olofsholm does not allow for any intragroup comparison of dietary patterns, the range of values—with one outlier (004-14)—are interesting for future consideration in studies of social identity in the Viking world. Barrett and colleagues argued, for instance, that the elevated $\delta^{13}\text{C}$ values in Viking Age skeletons compared with Pictish skeletons on Orkney reflected a dietary cultural difference in terms of marine foods and fish consumption (Barrett et al., 2001; Barrett & Richards, 2004). A dietary study of burials from Birka also observed potential social patterns relating to diet, where marine isotopic values were more noticeable in males buried with weapons than burials of those without (Linderholm et al., 2008). In contrast to these studies, however, an analysis of Viking burials from Flakstad in Norway that compared “high” with “low” social status graves found no difference in dietary isotope ratios (Naumann, Krzewińska, et al., 2014). Overall, this would suggest that

relationship between social complexity and diet was highly variable in the Viking world.

The relatively low proportion of fish in the diet of the individuals interred at S:t Olofsholm is interesting and somewhat unexpected considering its geographical location but seemingly not unique on Gotland. Comparison with the diets of the Viking Age and Early Christian population sample from Ridanäs (Kosiba et al., 2007) suggests that aquatic foods were of secondary importance on Gotland during this period. By contrast, at Birka, there was overall greater reliance on, and more individual variation in, the consumption of freshwater fish and marine resources (see Figure SI.1). Noteworthy in the Birka sample is the high proportion of aquatic foods in the diet of one particular individual (B496), who was interred in an exceptionally richly furnished grave. Described by Linderholm et al. (2008) as a “man of the highest social standing” (p. 455), he was suggested—on the basis of low $\delta^{34}\text{S}$ values—to have been a migrant or at least not a permanent Birka resident (although it is now known that the $\delta^{34}\text{S}$ of 1.6‰ is not atypical of the region). In regions of medieval Europe, consumption of freshwater resources, particularly large freshwater and anadromous fish, such as pike and sturgeon, was inextricably linked to status (e.g., Dyer, 1994), the cost of such luxuries placing them out of reach of all but the wealthiest households. Low socioeconomic status may account for the lack of fish in the diets of the individuals interred at S:t Olofsholm. However, it is worth bearing in mind that the dietary models are only valid for people who were locals and consuming local resources.

4.2 | Linking sagas, folklore, and (bio)archaeology

The rich and colorful lore and mythology of the Norse, and the long research interest in the Viking Period—from 19th century antiquarians and onwards—has undoubtedly contributed to a sometimes-generalized understanding what a “Viking identity” entailed. Although, in recent years, these perceptions have been challenged in targeted studies that have used bioarchaeological scientific evidence (e.g., Margaryan et al., 2020; Price et al., 2019). By both contrasting and integrating ancient legends and folklore with (bio)archaeological evidence, a diverse sources can contribute equally to improved perceptions and insights into the lived reality of life during the Viking Age, but also how myths and legends were formed and maintained throughout the centuries until today (cf. Gazin-Schwartz & Holtorf, 1999).

As is often the case with ancient texts and myths relating to specific events, accounts and narratives relating to Saint Olaf, his visit(s) to Gotland, and the Christian conversion of the Gutes, vary. Mitchell (2014) discussed these narratives from *Guta Saga* to *Chronica Guthilandorum* as having important functions on Gotland in forming identities and cultural memories linked to perceptions and visions of the past. Should the archaeology at S:t Olofsholm be viewed in a similar manner? While the bioarchaeological evidence does not allow for specific answers as to who was buried on the site, it adds an additional layer of narrative to the perceived notion of how a Christian cultural

identity was formed on Gotland during a period of significant social change with mobility and extensive trading routes across the Baltic Sea and beyond.

4.3 | Limitations

While Bayesian reconstruction of diet using carbon, nitrogen, and sulfur isotope ratios is based on contemporary and “local” food source isotope data, these data are limited in number. It is acknowledged that additional food source studies are required to ensure the representativeness of model parameters. The archaeological landscape at S:t Olofsholm is only partly excavated, and there are indications that additional burials are present south of the chapel. Bioarchaeological analyses of these burials may shed further insight into the legends and myths associated with Olaf Haraldsson on Gotland.

5 | CONCLUSION

The archaeological evidence from S:t Olofsholm has enabled a rare opportunity to explore the link between ancient medieval legends and sagas, local folklore, and bioarchaeology within a combined research narrative. The discovery of human remains with evidence of violent deaths and migration corroborate those elements of *Guta Saga*, *Heimskringla*, and *Chronica Guthilandorum* that describe the site of S:t Olofsholm as a place of cultural contact and conflict. Bioarchaeological evidence cannot confirm specific accounts narrated in medieval sources; nevertheless, it provides a certain element of consistency as to some of the key themes in these sources, namely, the interconnection of societal, political, and religious contacts and conflicts.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

Data available in article supplementary material.

ETHICS STATEMENT

Permission to excavate and undertake research on burials at S:t Olofsholm was granted by the County Administration Board of Gotland (License numbers: 431-477-123; 432-280-14) to Dan Carlsson, Arendus. The research ethics of the study was evaluated and supported by the School of History, Classics and Archaeology Ethics Committee, University of Edinburgh (15 November, 2021).

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