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BRONZE AGE CATTLE TEETH AND CREMATIONS FROM A MONUMENTAL BURIAL CAIRN IN SELKÄKANGAS, FINLAND: NEW RADIOCARBON DATES AND ISOTOPIC ANALYSIS

In this paper we present new data from the monumental Bronze Age cairn of Selkäkangas, Nakkila, excavated by the Department of Archaeology of the University of Turku in 1978–1981. Only burnt human bone and unburnt cattle teeth were recovered from the cairn. New radiocarbon-dates from the cremations and a cattle tooth indicate that the cairn was used for burials or rituals several times during the Early Bronze Age. One tooth was selected for isotope (oxygen O, carbon C and strontium Sr) analyses. Observed change in enamel $\delta^{13}C$, corresponding with increasing age, could reflect the cessation of milk consumption and increasing contribution of plant feed. In addition, this could also indicate signs of the changing plant food type according to outdoor/indoor feeding season in a similar manner evident during the historical period. Cattle were important in rituals practised in the Selkäkangas cairn and the deposition of unburnt teeth had a specific meaning.

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Introduction

A Bronze Age monumental cairn situated at Selkäkangas in Viikkala (Nakkila county) in the Satakunta region of western Finland was excavated in 1978–1981 by the Department of Archaeology of the University of Turku (Fig. 1). The cairn was poor in finds: only burnt bone and unburnt cattle teeth were recovered. Burnt bones were analysed and demonstrated to be human in origin (Vormisto 1985, 151 ff.). At the time of the excavations no finds that could date the structure were found, nor was enough organic material obtainable for radiocarbon-dating methods

Fig. 1. The location of sites mentioned in the text. Map by Hannu Ojanen, MTT Agrifood Research Finland.

available at that time. During the excavations cattle teeth were interpreted as modern, it was believed that Bronze Age unburnt bone could not have survived in the acid soil of Finland (Kuokkanen & Korkeakoski-Väisänen 1985; Vormisto 1985, 151 f.). However, the large size of the cairn, the presence of a stone slab cist and the height (30 m) above modern sea level all showed dating to the Early Bronze Age (Salo 1981, 176; Kuokkanen & Korkeakoski-Väisänen 1985, 10, 15 f.).

New research and new research methods opened further possibilities for investigating the Selkäkangas cairn. In 2010 one of the cattle teeth was radiocarbon dated and shown to date to the Early Bronze Age (3086 ± 30 BP, 1430–1270 cal BC, Hela 2496) (Bläuer & Kantanen 2013). This is the oldest radiocarbon dated cattle bone found in mainland Finland to date. As radiocarbon dating of burnt bone became possible, the cremations were also dated.

The living conditions and environment of the cattle in Bronze Age Satakunta were studied using isotopic analyses. This article presents new results from the Selkäkangas cairn and these are discussed in the context of general Bronze Age ritual and economy.

Bronze Age economy

To date only one radiocarbon-dated Stone Age domestic animal bone has been found from the Finnish mainland – a sheep or goat bone from a Late Neolithic Kiukainen culture site in Pietarsaari (3679 ± 33 BP, 2200–1950 cal BC, Ua-43043) (Bläuer & Kantanen 2013). In Åland the oldest dated domestic animal bone dates to approximately the same Late Neolithic period, ca 2000 cal BC (Storå 2000, 70 f.). The signs of the earliest agriculture in Satakunta area date to the late Stone Age (Vuorela 1991, 8 ff.; Vuorela & Hicks 1996), when the first cultivated clearings emerged. The very first signs of cereal cultivation visible in the pollen record in the Satakunta area are from Harjavalta 3480 ± 90 BP (1920–1700 cal BC, Hel-2404) and Huittinen (1700–1800 cal BC, Hel-357), where the soil was suitable for primitive cultivation (Vuorela 1991, 17 ff.). However, even if sporadic cultivation and one domestic animal bone are associated with Kiukainen culture, site location and faunal analyses indicate increasing reliance on marine resources and especially seal hunting (Zvelebil 1981, 160; Edgren 1998, 112; Bläuer & Kantanen 2013).

The following Bronze Age coastal culture seems to be connected both to sea and land. On the one hand, the location of the cairns and cultural connections are sea-oriented and seal hunting still seemed to be an important part of subsistence (Tuovinen 2002, 273 f.; Bläuer & Kantanen 2013). On the other hand, this is the period when the first definite signs of cattle and permanent field cultivation emerge and cultivation became a more prominent part of subsistence than before (Holmblad 2010, 159; Bläuer & Kantanen 2013). Early Metal period settlement sites in Finland often seem to include either domestic animal bones or seal bones (Bläuer & Kantanen 2013). Perhaps there were separate sites for sealing and animal husbandry used by a single population, indicating different environmental requirements for sealing and animal husbandry. However, the presence of two different cultural groups with different subsistence strategies during this period cannot be excluded, as local cultural change has been connected with immigrants from Scandinavian Bronze Age culture (see below). Also, the youngest phase of local Late Neolithic Kiukainen culture is contemporary with Early Bronze Age (Asplund 2008, 66). Animal husbandry could have been first practised only or mostly among immigrants and local people adopted it gradually (for the discussion concerning immigration or and cultural adaptation in Bronze Age Finland, see Tuovinen 2002, 57 f.).

In an environment where cattle survival over winter requires a significant amount of work and intensive winter feeding (present-day mean monthly air temperature in the area near <0 °C from November to April [Kortelainen 2008]), enough reward is needed to make this profitable. Cattle are more demanding to tend than sheep, and require different types of fodder than elk and reindeer, the native Finnish ruminants, and in order to keep the population viable the herd size needs to be sufficient (Hansson 1908, 14, 37; Bogucki 1988, 85; Welinder et al. 1998, 368). Cattle were necessary animals for permanent field cultivation as fields needed fertilizing with animal dung (Welinder et al. 1998, 32 ff.; Niemelä 2008, 48). In swidden agriculture dung is not needed as the field is abandoned after a few years of cultivation following soil exhaustion (Soininen 1975, 54 ff.; Orrman 2003, 103). In Swedish Bronze Age petroglyphs, cultivation, fertility and cattle are often depicted motifs (Welinder et al. 1998, 210). Cattle and their manure enabled good crops and cattle were also a source of milk and food connected with a new life. Milk could have been an important by-product, but only if the human population in question was tolerant to lactose. The history of lactose-persistence and its spread to northern countries is still partly unknown, but at least the Mesolithic hunter-gatherer population and the following Neolithic population were probably lactose intolerant (cf. Malmström et al. 2010; Gerbault et al. 2011). However, it is possible that lactose-tolerance was already established in western and southern Finland before the early Bronze Age (Vuorisalo et al. 2012). Keeping cattle for meat would only be sensible if enough animals were raised for significant input to the diet and no other sources of mammalian protein (like elk, reindeer or seal) were available from hunting. Also, agriculture and livestock husbandry enable denser populations than hunting and gathering can support (Barker 2006, 398 ff.). However, the reasons for cattle husbandry were not necessarily economic. Domestic animals can be important symbols, representing the identity of a particular group beyond their practical or subsistence-based needs (Maj 2009, 69; Stammler-Gossmann 2010).

The Bronze Age environment of the cairn

The Selkäkangas cairn was built in a marine environment, in a low and narrow moraine ridge that during the Late Stone Age or Early Bronze Age (1600 BC) was a long peninsula in a vast bay on the north-eastern side of the modern valley of Kokemäenjoki. Nowadays the Selkäkangas cairn is situated ca 2 km from the river Kokemäki. The nearest Bronze Age settlement sites are located one hundred metres from the cairns, but whether the sites were contemporaneous, remains unverified.

Because of land uplift through glacial action, the Satakunta area was, and still is, an area of constant change. New marshland and meadows were created in a few generations. Large-scale changes took only centuries – bays closed and the river deltas moved westwards (Vuorela 2000, Appendices 3–5).

The people who built Selkäkangas cairn

Monumental cairns were built near the seashore during the Early Bronze Age, especially in Satakunta. This tradition is likely to date to the Late Stone Age (in local chronology), but it is certain that the oldest cairns with burnt bones date to 1500–1300 BC (Period II in Scandinavian chronology) (Asplund 2011, 46 f.). Cairns were not only graves, but also had a deeper symbolic meaning, representing linkage and continuity in the landscape (Asplund 2008, 83). Cremation burials, building of burial cairns and the Scandinavian bronze artefacts associated with the burials have been interpreted as signs of the new religious ideology spreading from Sweden to Satakunta (Salo 2008, 107; Hiekkanen 2010, 275 ff.). The immigrants would have used the marine resources, like seal and fish, but also lush meadows and uncultivated land resources. Settlement expansion was especially dense in the mouth of the River Kokemäenjoki and monumental cairns in the Viikkala area are likely to represent immigration during the Early Bronze Age. However, this only deepened the already existing connection between the Finnish coastal area and Scandinavia (Salo 1981, 338 f., 345, 424 ff.).

Christian Carpelan sees the immigrants mainly as merchants, purchasing goods for Swedish central areas, which in turn traded them for bronze from central Europe. Some of these tradesmen stayed in Finland and were assimilated into the local society, bringing new religious and social ideas (Carpelan 1999, 271 f.). Perhaps they brought new genes as well, as substantial male-biased Scandinavian gene flow to the south-western Finnish human population has been suggested (Palo et al. 2009).

Animal bones in Bronze Age burials

Burnt or unburnt animal bones are sometimes found in Bronze Age cairns in Finland, but they are not very common. In Satakunta, animal bones were found in 13 of 75 cairns dating from the Bronze Age to early Iron Age (Lahtiperä 1970, 216 ff.; Salo 1970, 134). Elsewhere in Finland there are no securely dated Bronze Age burial cairns containing animal bones (Tuovinen 2002, 173; Okkonen 2003, 76 ff.; Taavitsainen 2003; Saipio 2011, 20 ff.). Secure dating of the bones found in cairns is difficult without radiocarbon dating as they can sometimes represent post-burial or even recent activities (Asplund 2011; Tourunen 2011, 65).

Bronze Age burials in Sweden sometimes included animal bones, but mostly burnt lamb bones; unburnt teeth or cattle bones are sometimes present but not common (Gejvall 1948, table I; 1961, 162 ff.; Baudou 1968, 158 ff.; Lundström 1970, 26; Mattisson 1994; Persson et al. 2002, 24 ff.; Thedéen 2004; Feldt 2005, 312 ff.; Strömberg 2005, 266). An unburnt cattle tooth was found in one Late Bronze Age burial from Uppland (Jonsson 2008; Lindblom et al. 2008). In Gotland there is one Late Bronze Age cairn with burnt tooth fragments from cattle or horse (Gejvall 1958). However, unburnt teeth of cattle and horse are found in Finnish and Swedish burials dating to the Iron Age (e.g. Sigvallius 1994, 128 ff.; Formisto 1996, 84; Hårding 2002, 220; Telldahl 2008, 27). In Estonia the animal bones from Bronze Age burials have not yet been investigated in detail (pers. comm. Lembi Lõugas 16.1.2012), but domestic animal bones (cattle, sheep or goat, pig, dog and even horse) associated with Bronze Age or Pre-Roman Iron Age burials have been found at many places (e.g. Maldre 2000; Kriiska et al. 1997, 37 ff.; Laneman 2012).

Burnt or unburnt: cremation as ritual

Cremated human bones have been occasionally found in Finland from Stone Age sites (e.g. Tourunen & Troy 2011), but cremation burials, associated with stone cairns, became widespread during the Bronze Age (Salo 1981, 186). Cremation as a burial ritual could relate to the Indo-European ideology of rapidly releasing the soul of the dead or transforming the deceased as part of the world of death (Kaliff 1997, 81; Sørensen 2010, 59). However, the shift in burial practices was gradual: in the beginning of the Bronze Age burnt bones were sometimes placed in a cist or coffin large enough for inhumation (Sørensen 2010, 60). This is also the case in Selkäkangas.

Burning or destroying objects, practised sometimes in Bronze Age Sweden and in Iron Age Finland, could have represented ritual 'death' or releasing the object's 'spirit' (Salo 1981, 187 f.; Kaliff 1997, 98; Wessman 2010, 62). In Finland, bronze artefacts deposited in graves have not been burnt (Salo 1981, 187 f.). In contrast, burnt sheep, goat, dog and cattle bones were found in two Bronze Age cairns in Satakunta (Lahtiperä 1970, 202, 206).

Burnt animal bones found in Iron Age human cremations are often interpreted as offerings burnt with the body in the pyre (Sigvallius 1994, 6; Formisto 1996, 85 f.). McKinley (1994, 96 f.) divided burnt animal offerings in cremation burials into three categories: complete animals (like horse and dog) intended as status symbols or personal possessions, complete or partial animals (cattle, sheep, pig) intended as food offerings and amulets (bone pendants). Only partly burnt animal bones deposited with cremation burials have been interpreted as bones from a funeral feast, thrown later into the pyre or located in peripheral areas of the pyre (Iregren & Jaanusson 1987; McKinley 1994, 97 f.; Sigvallius 1994, 128).

Unburnt animal teeth found in burials require a different interpretation than that for the burnt animal bones (Sigvallius 1994, 128; Formisto 1996, 84; Hårding 2002, 220; Wessman 2010, 93). They have been interpreted as being remnants of a funeral feast or being later than the cremation burial itself: either intrusive, and not belonging to the burial rituals at all, or belonging to rituals later than the burial (Vormisto 1985, 151 f.; Bond 1994, 126; Wessman 2010, 93). Selecting teeth as an element could have also been deliberate. Teeth or skulls could be seen to represent animal souls or life force and skulls have been used in different kinds of offerings, even close to the modern day (Hårding 2002, 220; Carlie 2004, 116, 135 f.; Hukantaival 2009).

The monumental cairn in Selkäkangas

The Selkäkangas cairn of Viikkala village in Nakkila was first found among other two Bronze Age cairns during a survey in 1952. The Selkäkangas cairn and two other adjacent cairns are located on a ca 160 m long stretch of a west–east orientated moraine ridge. The two other cairns are built of stone and have a round base with a diameter of ca 7 m and a height of 1 m and 0.4 m respectively. Between these smaller constructions lay the Selkäkangas cairn, which is a 43 m long rectangular structure; its western end is 11 m wide and its eastern 9 m (Fig. 2).

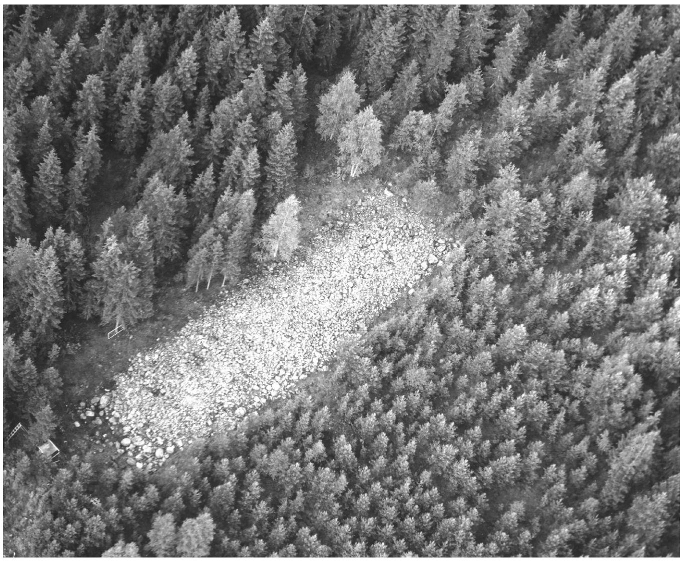

Fig. 2. Cairn of Selkäkangas. Seen from the north-east. Photo Porin Lentopalvelu Oy. Archives of the University of Turku, Archaeology.

The cairn is 1 m high at the edges and 1.4 m in the centre (NBA Register of protected sites: Nakkila Selkäkangas (Viikala I) 531010027).

The Selkäkangas cairn is exceptional in its large size and rectangular form: the size of Bronze Age cairns in the Satakunta and Kokemäenjoki area ranges from 5 to over 40 m in diameter, but most have diameters under 10 m (Salo 1981, 131 f.). The Selkäkangas structure consists of over 500 m^2 of stones collected from the immediate area of the cairn. The stones are of local sandstone, widely used in other cairns of the area. The reddish colour of the sandstone makes the cairn stand out from its environment. The largest stones were found in the lowest levels of the structure, but otherwise the stones were piled without clear order and they did not form a smooth surface.

During the excavations the whole cairn was excavated: three inner structures, a stone wall, a stone slab cist and a stone circle, were revealed (Fig. 3). These were constructed more carefully than the rough outer appearance. The largest of these was the rectangular stone wall, 40 m long and 5–6 m wide. It was carefully laid with sandstone rocks and slabs, aimed at a smooth outer surface. The inner wall surface was left irregular. Inside the wall was an east-west oriented stone slab cist.

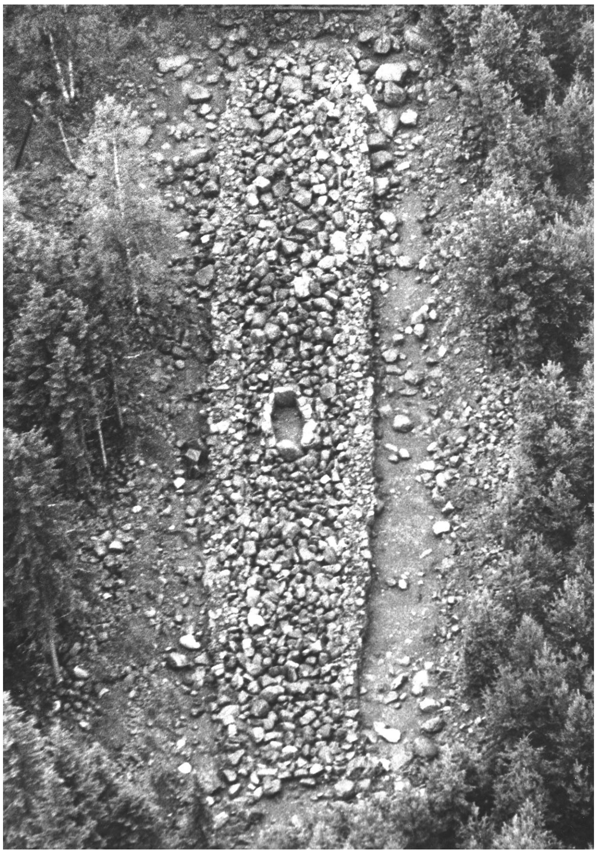

Fig. 3. Two of the inner structures of Selkäkangas cairn, a stone wall and a stone slab cist. The stone circle is not visible. Seen from the east. Photo Porin Lentopalvelu Oy/J. Forsman. Archives of the University of Turku, Archaeology.

The outer measurements of the cist were 3.6 × 2.2 m. Unlike in the stone wall, the cist inner surfaces were smooth and the outer surface uneven. An additional structure was discovered on the axis of the cairn. Approximately one metre from the western end of the stone cist a circle of stones with a diameter of approximately 3 m was visible in the lower layers of stones (Kuokkanen & Korkeakoski-Väisänen 1985, 11 ff.).

Cremations and cattle teeth

The cremations and cattle teeth were deposited in the middle section and to the northern side of the cairn (Fig. 4, Table 1). Cremated human bones and unburnt cattle teeth found in the cairn were analysed by Vormisto (1985) and partly re-analysed during this study (TYA 184: 9 and cattle teeth). The first asymmetric concentration of burnt human bone was located at the western end of the slab cist (TYA 169: 1–5). The burnt bones (640 g) were crushed, clean of soot and derived from at least one unsexed adult. A small concentration of human bones (20 g), which was not treated as a separate cremation in the 1985 analysis, but was identified as a separate entity during later archaeological analysis, was situated outside the south-east corner of the stone cist (TYA 184: 9). A third concentration of burnt bones (300 g) from at least one adult was recovered from

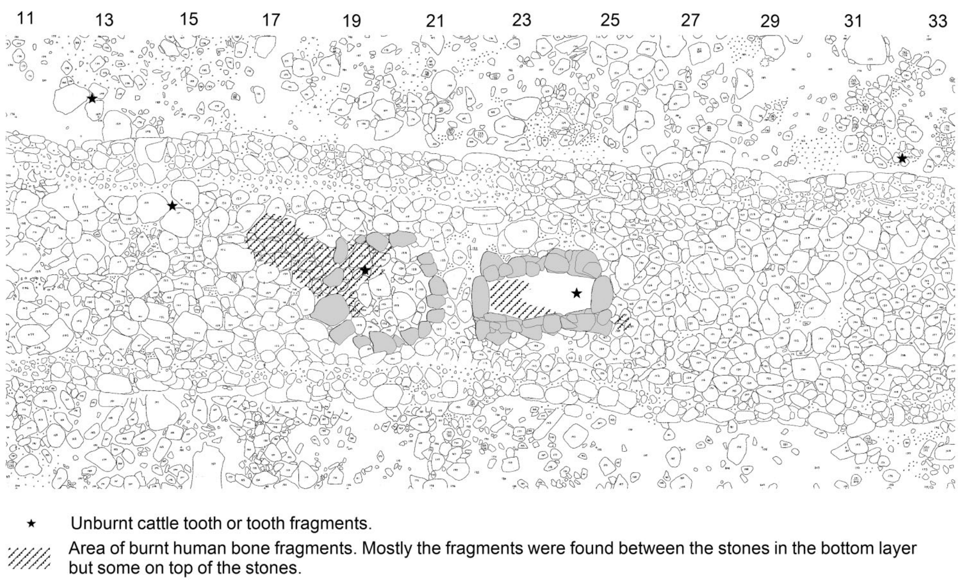

Fig. 4. The middle section of the Selkäkangas cairn, cattle tooth and burnt bone concentrations (TYA 184: 12 not shown). Original drawing by Timo Kuokkanen 1980, modified by Kristiina Korkeakoski-Väisänen and Heidi Viljanen 2012.

Table 1. Bone finds in Selkäkangas cairn. *Analysis by Vormisto (1985)

Find location	TYA	Species	Elements	Laboratory code	Dating	Comments
Stone cist	TYA 169: 1–5	Human	Cremation	Ua-36182	3190 ± 35 BP (1530–1400 cal BC)	640 g, adult*
	TYA 169: 6	Cattle	Unburnt maxillary molar fragments			
Near stone wall	TYA 169: 7	Cattle	Unburnt maxillary molar	Hela-2496	3086 ± 30 BP (1430–1270 cal BC)	Bläuer & Kantanen 2013
Inside stone circle	TYA 184: 2–8, 13–15	Human	Cremation	Ua-36183	3030 ± 30 BP (1400–1190 cal BC)	300 g, adult*
	TYA 184: 2	Unidentified (cattle?)	Unburnt tooth fragment (cattle?) and three tiny burnt bone fragments			
	TYA 184: 3	Cattle	Unburnt molar enamel fragments			
Outside SE corner of the stone cist	TYA 184: 9	Human	Cremation	Ua-43366	3030 ± 35 BP (1410–1190 cal BC)	20 g
Outside the stone wall, east	TYA 184: 1	Cattle	Unburnt maxillary molar			Only fragmentary crown, no roots, left side
Outside the stone wall, west	TYA 184: 11	Cattle	Unworn molar enamel fragments			
Outside the stone circle	TYA 184: 12	Unidentified	Unidentified burnt bone fragments			

Fig. 5. Cattle tooth with preserved root section (TYA 169: 7). Photo by Auli Bläuer.

inside and partly outside the western side of the circle (TYA 184: 2–8, 13–15) (Kuokkanen & Korkeakoski-Väisänen 1985, 15 f.; Vormisto 1985, 152).

None of the burials contained any grave goods except cattle teeth (Figs 5, 6). Unburnt cattle maxillary molar fragments were found at the eastern end of the cist (TYA 169: 6). Also among the burnt human bone in the stone circle were unburnt cattle molar enamel fragments (TYA 184: 2–3). However, some cattle teeth were deposited in the cairn without associated burnt human bones. The cattle tooth examined more closely in this study was found near the inner surface of the stone wall, ca 3 m from the stone circle (TYA 169: 7). It was identified as a cattle maxillary molar (M2 or M3) from the right side. Its exact place in the tooth row was unfortunately not defined by morphological analysis as the side of the tooth was broken. It was selected for radiocarbon dating because it had preserved root parts, unlike other cattle teeth in the cairn: radiocarbon dating of tooth enamel is possible but challenging and the results could be inaccurate (Hedges et al. 1995; Surovell 2000). Near this tooth on the outer side of the stone wall there were molar enamel fragments from an unworn cattle molar (TYA 184: 11). Other cattle teeth fragments were found near the stone wall but outside, approximately 7 m east of the stone cist (TYA 184: 1). Two unidentified burnt bone fragments (TYA 184: 12) were recovered ca 8 m outside the stone circle.

Fig. 6. Cattle teeth from the Selkäkangas cairn. From right to left: TYA 184: 1, 2, 3; 169: 6 and 184: 11. Photo by Auli Bläuer.

Isotope ecology

The stable isotope compositions of mammalian teeth have the capacity to record a vast amount of detail about the living conditions that the individual experienced, including climate and diet (see review by e.g. Kohn & Cerling 2002). Tooth enamel preserves primary, biogenic stable isotope signals on time scales extending to millions of years in various depositional environments (e.g. Lee-Thorp & Sponheimer 2003). Considering the time and mode of deposition of the cattle molar investigated here, our isotopic data are likely to reflect primary, in vivo signatures. The isotopic composition of oxygen ($\delta^{18}O$) in the skeletal mineral is intricately linked to the $\delta^{18}O$ values of precipitation, which at high and middle latitudes are strongly correlated with air temperature. Mammalian carbon isotope values ($\delta^{13}C$) give information on the diet of the animal. Herbivores, including cattle, in northern Europe typically display relatively low (–21 to –8‰) bioapatite $\delta^{13}C$ values indicative of the dominance of C3 photosynthesizing plants in their environment. Calves, while suckling, are on a trophic level higher than their strictly herbivorous mothers. This difference in diet is also manifested in the isotope composition of carbon and nitrogen ($\delta^{15}N$) in the skeletal tissues. The isotopic ratios of strontium ($^{87}Sr/^{86}Sr$), derived from bio-available Sr in soils through the weathering of underlying bedrock, can be used to trace place of residence. Thus, isotopic analysis has the potential to reveal details about changes in animal diet and location in a particular, determined age.

Methods

Isotopes

Only one tooth (TYA 169: 7) had preserved roots, which enabled radiocarbon dating. This tooth was also selected for the isotope (oxygen O, carbon C and strontium Sr) analyses. For the analyses of stable oxygen and carbon isotope compositions, and $^{87}Sr/^{86}Sr$ ratios, a series of 7 samples of tooth enamel was taken from along the growth axis of the tooth, from the cementoenamel junction (CEJ) to the crown tip. Standard methods of pretreatment (Bocherens et al. 1996) were used to remove possible contaminants from enamel powders. The oxygen ($\delta^{18}O_C$) and carbon isotope ($\delta^{13}C$) compositions of the structural carbonate of enamel bioapatite were analysed at the Laboratory of Chronology, Finnish Museum of Natural History on a ThermoFinnigan GasBenchII coupled to a Finnigan Delta Plus XL mass spectrometer. The isotope data are reported as δ-values relative to the VPDB standard, in permil units (‰). The reproducibility (1σ) of sample measurement is ±0.1 ‰ for $\delta^{13}C$ and ±0.2 ‰ for $\delta^{18}O$. For the purposes of estimating $\delta^{18}O_w$ values of ingested ambient waters, the analysed $\delta^{18}O_C$ values were first converted to $\delta^{18}O_p$ values for biophosphate according to the $\delta^{18}O_C – \delta^{18}O_p$ correlation (Pellegrini et al. 2011), and then to $\delta^{18}O_w$ values following D'Angela and Longinelli (1990). The approach is complicated by possible variations in the $\delta^{18}O_C - \delta^{18}O_p$ spacing (Pellegrini et al. 2011), which adds an uncertainty of ±1.3‰ to the estimated $\delta^{18}O_w$ values.

The $^{87}Sr/^{86}Sr$ analysis was carried out on two samples: one taken from the crown tip and one closest to the CEJ. Sr was separated and purified in micro-columns using Sr-spec resin and loaded on Ta-filaments. The $^{87}Sr/^{86}Sr$ isotopic ratios were measured at the Geological Survey of Finland, Espoo, on a VG Sector 54 thermal ionization mass spectrometer, and corrected for instrumental mass fractionation. The long-term reproducibility of measurement for the SRM987 standard is ±0.000012 (2σ).

Results

Radiocarbon dates of the cremations

The cremation inside the cist (TYA 169: 1–5) was dated to 3190 ± 35 BP (1530–1400 cal BC (95.4%), Ua-36182) (Fig. 7). This date also indicates the building of the cist. The cremation inside the stone circle (TYA 184: 2–8, 13–15) is later, 3030 ± 30 BP (1400–1190 cal BC (95.4%), Ua-36183), as is the cremation outside the south-east corner of the cist (TYA 184: 9) 3030±35 BP (1410–1190 cal BC (94.1%), Ua-43366). The two last cremations have almost identical radiocarbon dates, and they may derive from one individual as the cremation outside the cist includes only ca 20 g of bones and no overlapping skeletal elements were found in the two concentrations of bone.

Stable isotopes

The results of the carbon, oxygen and strontium isotope analyses are shown in Table 2 and Figure 8. The $\delta^{13}C$ value decreases consistently from the crown tip (sample NAK0) to the CEJ (NAK2.5). The total change amounts to 1.3‰ over

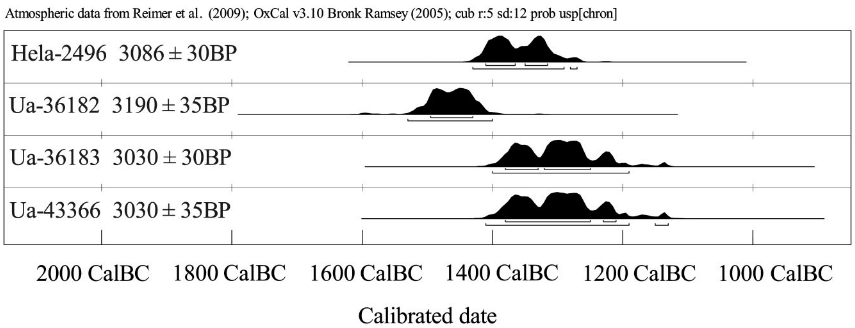

Fig. 7. Selkäkangas cairn bone dates. OxCal v.3.10 (Bronk Ramsey 1995; 2001), using the IntCal09 calibration data (Reimer et al. 2009).

Table 2. Results of isotopic analyses. *Value is a mean of two analyses. δ13C NAK0 = –11.3 and –11.4‰; NAK 2.5 = –12.5 and –12.6‰. δ18O NAK0 = –10.0 and –10.1‰; NAK 2.5 = –8.0 and –8.2‰.

Sample	Distance from crown tip (mm)	$\delta^{13}C$ (VPDB)	$\delta^{18}O$ (VPDB)	$^{87}Sr/^{86}Sr$ (± 2se)
NAK0	0–5	–11.3*	–10.1*	0.73007 (.000015)
NAK0.5	5–7	–11.7	–9.3	
NAK0.8	8–10	–11.7	–8.7	
NAK1.3	13–14	–12.1	–7.9	
NAK1.6	16–17	–12.1	–7.3	
NAK1.9	19–21	–12.1	–7.2	
NAK2.5	25–30	–12.6*	–8.1*	0.73039 (.000015)

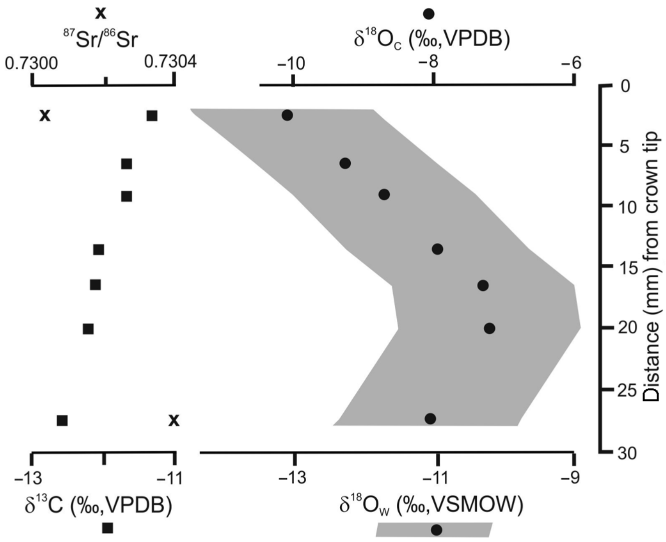

Fig. 8. The $\delta^{13}C$ (squares), $\delta^{18}O$ (dots) and $^{87}Sr/^{86}Sr$ values (crosses) in the tooth enamel samples, and estimated $\delta^{18}O$ range of ingested ambient water (dots, grey shading = uncertainty of ± 1.3‰) along the growth axis of the tooth.

the sampled 3 cm interval. A contrasting trend is seen in the oxygen isotope data: the crown tip has the lowest $\delta^{18}O_C$ value. The $\delta^{18}O_C$ value of subsequent samples increases steadily towards the CEJ, reaching a maximum at NAK1.9, and decreases again by ~1‰ in the most apical (closest to the CEJ) sample (NAK2.5). The overall range of $\delta^{18}O$ values is 2.9‰.

The two samples analysed for Sr isotope compositions yielded $^{87}Sr/^{86}Sr$ values that are significantly different at the 2 σ measurement uncertainty level. The coronal (direction towards crown tip) sample (NAK0) gave a $^{87}Sr/^{86}Sr$ ratio of 0.73007 (±0.000015, 2SE), and the apical sample (NAK2.5) a higher value of 0.73039 (±0.000015, 2SE).

Discussion

Feeding of cattle

The amount of available animal fodder is dependent on local landscape and climate. The land uplift created new meadows, which were likely to be a good source of hay and reeds. The Local Bronze Age climate can be studied through $\delta^{18}O$ values for the Selkäkangas cattle tooth. Assuming ca 4 mm of enamel represents 1 month of accretion (Balasse et al. 2001), the isotope profiles should reflect a time period of ca 8 months. This supports the interpretation that the $\delta^{18}O_C$ profile reflects an incomplete annual climate cycle, missing the most negative, i.e. winter, precipitation signal. The amplitude of the enamel $\delta^{18}O_C$ profile closely resembles the magnitude of seasonal variation in $\delta^{18}O$ values of present-day precipitation in Olkiluoto (Kortelainen 2008), ca 35 km to the south-west (Fig. 1). The calculated $\delta^{18}O_w$ values for environmental waters taken up, most likely derived from shallow ground waters or surface waters fed by local precipitation, range from –13.3 to –10.3 (±1.3) ‰. This range of values is very similar to modern $\delta^{18}O$ values for precipitation in the region (–14 to –10.5‰ in Olkiluoto). Thus, the $\delta^{18}O_C$ data could be taken to imply that average annual temperatures and their seasonal amplitude of variation in the late Bronze Age was rather similar to that prevailing in the region today. However, if preliminary observations of possible 'dampening' of the seasonal signal as expressed in $\delta^{18}O_C$ values of bioapatite carbonate (Martin et al. 2008; Pellegrini et al. 2011) are correct, the seasonal variation in climate during the Bronze Age in south-western Finland might have been stronger than today, meaning colder winters or warmer summers, or both.

The values in the Selkäkangas tooth are characteristic of animals feeding exclusively on C3 photosynthesizing plants that dominate at these latitudes. A cyclical variation comparable to $\delta^{18}O_C$ is absent. This is logical, as the cattle were most likely sheltered indoors for the cold season or at least given fodder collected and stored during the growing season. The steady reduction in enamel $\delta^{13}C$ values with distance from the crown tip, corresponding with increasing age, might reflect the cessation of milk consumption and increasing contribution of plant feed. This hypothesis is supported by an elevated $\delta^{15}N$ value for collagen in the tooth (pers. comm. Markku Oinonen 22.5.2012), measured during another project, strongly suggesting that the molar in question is an M2, which forms during the first 1–13 months of the animal's life. Thus it is quite probable that the progressively more negative $\delta^{13}C$ values towards the CEJ reflect decreasing input of milk in the animal's diet. We note that weaning is usually considered to result in an increase of the $\delta^{13}C$ values of the animal, as milk is assumed to have lower $\delta^{13}C$ values than C3 plant material due to its lipid content (e.g. Balasse et al. 2001). However, the isotopic composition of cow milk seems to depend on the type of plant material consumed: cows feeding on C3 plants produce milk that has higher $\delta^{13}C$ than the ingested plant material, whereas the opposite was observed for animals consuming plants using the C4-photosynthetic pathway (Metges et al. 1990; Knobbe et al. 2006).

In addition, the observed variation in $\delta^{13}C$ could also be a sign of the changing plant food type according to outdoor/indoor feeding season. Cattle could have been grazing in forest near the settlement during the summer and been fed with hay and reed collected from coastal meadows during the winter. The system of forest grazing and reserving certain meadows solely for winter fodder was used in Finland until hay cultivation was adopted in the late 19th – early 20th century (Talve 1997, 66 ff.). In this scenario, the higher $\delta^{13}C$ levels of the subsamples in the direction of the crown tip, which according to the $\delta^{18}O_C$ profile reflect the late winter/early spring, could be a reflection of straw fodder collected from coastal meadows, as opposed to the lower $\delta^{13}C$ values towards the CEJ for summer/early autumn feeding in the forests. This is consistent with what is known of plant $\delta^{13}C$ values in open versus closed environments, and their response to increased environmental levels of salinity (e.g. Heaton 1999). However, it is probable that the observed $\delta^{13}C$ variation is mostly dominated by the weaning signal.

The Sr isotope composition of the enamel is consistent with the range of $^{87}Sr/^{86}Sr$ ratios expected for the region estimated from bedrock age, and contents of Rb and Sr (Kaislaniemi 2009), and thus, with the local origin of the animal. The difference in Sr-isotope values for the two analysed subsamples suggests a different provenance for the food ingested during the formation of the crown tip than for the plants consumed ca 8 months later when the enamel at the CEJ was mineralizing. It should be noted that the Sr-isotope signal of ingested food is unaffected by the form in which it is delivered – grass and milk produced at the same location will have the same $^{87}Sr/^{86}Sr$ ratios. Unfortunately, more precise estimates of the food source region cannot be made as we lack information on the variations in biologically available $^{87}Sr/^{86}Sr$ ratios of the soils and vegetation in the study area. It is noteworthy, however, that the lower $^{87}Sr/^{86}Sr$ ratio of the crown-tip subsample is consistent with digestion of fodder harvested from close to the coast, where marine aerosol Sr from the Baltic Sea, with relatively low $^{87}Sr/^{86}Sr$ ratios (e.g. Widerlund & Andersson 2006), can contribute to the Sr budget of soils. However, it is not impossible that the animal was grazing far from the settlement during the summer, where people could utilize fresh pastures and wild resources further from home, or that the animal was moved from one settlement site to another during its first year of life.

Cattle, ritual and economy

The deposition of cattle teeth and cremations are likely to be spatially connected in the cairn through ritual practice. The cairn was used for burials or rituals several times, as indicated by radiocarbon dating. Even if only one tooth was radiocarbon dated, it is likely that the others belong to the same time period and ritual practice. Some cattle teeth were clearly associated with the burials themselves, but some were deposited in the cairn without human bones. All the teeth were found near structures (stone circle, cist and wall), and thus apparently deposited carefully in particular locations. Moreover, all the archaeological deposits – burials and cattle teeth – were concentrated in the middle section of the cairn, on the northern side (Fig. 4). Thus, the deposition of the cremations and teeth was not random.

Cattle were important animals in the rituals practised in the Selkäkangas cairn. No other animal species were identified in the cairn, nor were there any other archaeological finds. However, the abundance of animal species found in burials does not necessarily correlate with their economic significance or abundance in the animal stock (Iregren 1974, 117; Welinder et al. 1998, 92). Bronze Age immigrants arrived from a cultural background where permanent field cultivation and animal husbandry were common (Welinder et al. 1998, 187 ff.). The Selkäkangas cattle tooth is the oldest radiocarbon-dated cattle bone in Finland, and it is possible that cattle were introduced to Finland during the Early Bronze Age. The reason for selecting cattle teeth by the immigrants that built Selkäkangas cairn could have been the need to emphasize their different identity and economy compared to that of the local population.

Some of the human cremations may represent token burials and not complete cremations in the same way that cattle teeth perhaps represent complete animals. Deposition of unburnt elements has had a different meaning than deposition of cremated human bones. Cattle are represented by depositions of a single tooth, as opposed to cremations that included several cranial and post-cranial elements (Vormisto 1985).

All teeth that were preserved well enough to be investigated in more detail were from the upper jaw. None of the locations where teeth or enamel fragments were found included evidence for more than one tooth being present. Thus, it seems that only a single tooth was detached from the skull and deposited in the cairn.

Conclusions

Radiocarbon dating of cremation burials from Selkäkangas cairn confirmed that they are contemporary with the dated cattle tooth and that the cairn dates to the Early Bronze Age. Both cremations and cattle teeth were located to the northern side in the middle section of the cairn, associated with the structures. Cattle were the only identified species, which were represented by carefully selected elements. The radiocarbon-dated cattle tooth is currently the oldest cattle bone from Finland, and it is possible that cattle were introduced into Finland during the Early Bronze Age by Scandinavian immigrants. Isotopic analysis of the cattle tooth indicates that it was an M2, formed during the first year of the animal's life, and that the recorded change in enamel $\delta^{13}C$ is likely to reflect the weaning process. In addition, a similar pattern could also result from a change in diet (plants) during the outdoor and indoor feeding season. The Sr isotope composition of the tooth corresponds to the local values, but the change in Sr values indicates that during its life the animal was moved from one location to another or that the summer and winter fodder derived from different sources.

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VEISED, KESKKOND JA RITUAAL: PRONKSIAEGSED VEISEHAMBAD SELKÄKANGASE MUISTSEST KALMEVAREST SOOMES

Resümee

Artiklis on esitatud uusi uurimisandmeid Selkäkangase (Nakkila maakond, Soome) pronksiaegse kalmevare kohta, mida kaevati Turu Ülikooli arheoloogia osakonna poolt aastatel 1978–1981. Sellest varest saadi vaid põlenud inimluid ja põle(ta)mata veise hambaid. Uued radiosüsinikudateeringud põletusmatustest ja veise hammastest viitavad korduvale kalmevare kasutusele vanemal pronksiajal, seda nii matmisteks kui ka rituaalide läbiviimisteks. Üks veisehammas valiti isotoopanalüüsideks (sh hapnik O, süsinik C ja strontsium Sr). Tulemused viitavad erinevatele veisesöötmistavadele, sh suviste karjamaade ja talvise söötmise erinevustele: tõenäoliselt karjatati loomi suvel metsastel aladel ning talveks varuti loomasööta mereäärsetelt luhtadelt, nagu on teada ka keskaja loomapidamise kohta. Selkäkangase kalmevaredes läbi viidud rituaalides oli veisel tähtis koht ja tema põletamata hammaste leidmisel sealt on eriline tähendus. Veis oli justkui põllumajandusliku eluviisi sümbol, tõstes esile erinevusi segamajanduslikku eluviisi praktiseerivate ja vaid küttimisest-korilusest elatuvate inimeste vahel.