Diet, Toothache and Burial Diversity

Tracing Social Status through Bioarchaeological Methods in Late Neolithic–Early Bronze Age Scania

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Abstract

Scholars have long discussed social hierarchies associated with the Early Bronze Age in southern Scandinavia. In this paper, social hierarchies are targeted through bioarchaeological methods. Fifty new radiocarbon dates from 50 individuals show that there is an increase in burial complexity from the Early Late Neolithic to the Early Bronze Age. Further, stable isotopes of carbon and nitrogen were analysed in 29 of the individuals and dental caries were then assessed in a data set of 598 post-canine teeth, to examine differences in diet between individuals associated with different inhumation practices. The nitrogen values indicate that manuring was practised during the period, but there was no statistical difference in diet or dental caries between burials. It is argued that different types of burials are associated with different social levels in society, but that there is not a higher meat consumption or visibly different food behaviour among individuals interpreted as being a member of the "elite".

Introduction

The Late Neolithic–Early Bronze Age of southern Scandinavia (*c.* 2300–1100 BC) spans over a period of a millennium or so. It is true that there is a distinct difference in material culture starting with Early Bronze Age period II (*c.* 1500 BC), but the periods predating this are often treated as homogeneous. Is homogeneity and shift in material culture also a homogeneity and shift in group identity? Recently, many new ^{14}C dates have been made on skeletal material dating from the Battle Axe Culture (BAC) to Early Bronze Age, both within the project "The Rise" (Bergerbrant *et al* 2017) and within my own research. This gives the opportunity to study the use of Neolithic and Bronze Age burials in more detail.

The formation of Bronze Age society of Southern Scandinavia is often understood as a development of chiefdoms where political power was upheld through prestige items of the elite (Vandkilde & Northover 1996, 305 ff.; Kristiansen 1999; Kristiansen 2011; Earle *et al.* 2015). This power strategy is referred to as network strategy (Kristiansen & Earle 2015). Sherratt (1997) argues that this kind of Bronze Age society has its foundation in the *Secondary Products Revolution* (SPR), where secondary products, such as milk and wool, increased in importance. The intensification of agricultural activities led to an economic surplus which allowed specialization and metal trade. The SPR would also allow a population increase, also considered to be a trigger for the development of hierarchical societies (Earle 1989). Skoglund (2009), however, provides evidence that the network strategy was not uniform in all of Southern Scandinavia during the Bronze Age, but rather occurred side by side with a corporate strategy. The corporate strategy is mostly associated with Neolithic societies. They are not primarily controlled by exchange of prestigious items but rather by reproduction of knowledge within all of the society. Kristiansen and Earle (2015) argue that the political systems differed between Neolithic and Bronze Age societies in that Neolithic political economies were based exclusively on local resources while politics during the Bronze Age were upheld through continuous trade with long-distance core areas. Skoglund suggests that the network strategy is probable in Scania and Denmark while the corporate strategy is applied further north. This, among other things, is demonstrated by the richly equipped barrows in the south not present further north. This is also suggested by Vandkilde and Northover (1996).

Social status could be demonstrated through prestige items, but also through diet. Food habits are closely connected to cultural settings and serves as more than just nutrition. These cultural differences might reflect differences in religion, taboos or social hierarchies. Isaksson (2000) found different dietary habits between peasants and the elite in the Vendel Period in Sweden, where meat was ranked as high-status food. Knipper *et al.* (2015), however, could not detect differences in diet in deviant burials, thought to be those of non-locals, associated with the Early Bronze Age Únětice culture in central Germany (c. 2200–1700/1660 BC). The deviant burials could not be associated either with non-local $^{87}Sr/^{86}Sr$ levels or a different diet than individuals buried in the more common type of Únětice burials. Dietary analyses based on stable isotopes could provide information about differences in diet related to, for instance, burials. Deviant burials of different sorts often intrigue archaeologists, leading to theories that these burials might relate to migrants or individuals of another social rank. However, relations between differences in burial practice and differences in diet seem to coincide only on a local scale. Le Bras-Goude *et al.* (2012) found some evidence for differences in diets between burial practices in the Languedoc region in France, possibly mirroring one pastoral and one agriculturalist group. Also Waterman *et al.* (2014) found differences in diets between several Neolithic and Copper Age sites in Portugal that could be expressions of social differentiation in consumption patterns. However, Giblin and Yerkes (2016) could not detect social hierarchization through dietary patterns in Copper Age Hungary.

In an ongoing study of stature based on 164 femora from South Swedish Middle-Late Neolithic, I conclude that there is an event of significantly increasing male statures in the Battle Axe Culture (BAC) in relation to the earlier period of Funnel Beaker Culture, and the partly contemporary Pitted Ware Culture. There might also be another event of increasing male stature between the early Late Neolithic (LNI) and the later Late Neolithic and Early Bronze Age (LNII–EBA), although not as significant as in the BAC (Tornberg in prep.). These changes in stature also correlate well with periods of migration and significant changes in material culture and social foundations, whereas stature remains more or less static in times of more archaeological stability. Social changes, and possible changes in social status, are also reflected in human biology. In this paper I will examine bioarchaeological approaches to social stratification in the late part of the Late Neolithic and the Early Bronze Age. The questions to be examined are: is the heterogeneity in burial customs traditionally associated with the South Scandinavian Late Neolithic and Early Bronze Age (inhumations in flat graves, gallery graves and barrows) related to a difference in chronology, and are there differences in dietary isotope values between individuals buried in these different grave types that cannot be explained by chronology?

Material and method

The material consists of radiocarbon dates of 50 individuals from the province of Scania, southernmost Sweden (Fig. 1). All dates span from Late Neolithic period I (LNI) to the Early Bronze Age period II–III (EBAII–III) and are performed at the AMS radiocarbon laboratory the ^{14}Chrono Centre, Queen's University, Belfast and at the Department of Geology, Lund University. Radiocarbon dates have then been calibrated (2 sigma) using Oxcal online (Oxcal v. 4.2).

Twenty-nine of the individuals (n=29 samples) dated to LNII–EBAII have also been studied for dietary isotopes of $\delta^{13}C$ and $\delta^{15}N$ in collagen. The 29 individuals were selected based on stage of preservation, where individuals with lower jaws were primarily chosen, and to represent the three dominant burial practices during the South Swedish Late Neolithic and Early Bronze Age (flat earth graves, gallery graves and barrows).

The levels of the carbon and nitrogen isotopes largely reflect the protein contribution to the diet (Hedges & Reynard, 2007). The level of $\delta^{13}C$ reflects whether the diet was based mainly on terrestrial or marine resources (Van der Merwe 1982; Schoeninger & DeNiro 1984), with levels lower than –20‰ considered entirely terrestrial and

Fig. 1. The regions concerned in this paper. **A**: The Vellinge area (Kyhlbjersbacken, Vellinge 27, Håslöv); **B**: The Trelleborg and Österlen area (Abbekås, Snorthög, Bollerup, Ahlbäcksbacken); **C**: The Kristianstad area (Ängamöllan, Nosaby, Öllsjö); **D**: Rörbäck.

up to –12‰ as entirely marine in northern Europe (Eriksson & Lidén 2013). The levels of $\delta^{15}N$ refer to the trophic level with an enrichment along the food chain commonly reported as about 3‰, animals preying on herbivores having values of about 9‰ on land (e.g. Schoeninger & DeNiro 1984; Eriksson & Lidén 2013). However, O'Connell *et al.* (2012) measured an enrichment in collagen as high as 6‰, resulting in an overestimation of animal protein in past human populations. The marine ecosystem is somewhat different, allowing more trophic levels and therefore higher $\delta^{15}N$ values (Schoeninger & DeNiro 1984). All analyses of dietary isotopes have been conducted at the ^{14}Chrono Centre in Belfast on individuals post-weaning. The collagen in the samples with a laboratory number below UBA-24991 was extracted through the modified Longin method developed by Brown *et al.* (1988) using a Vivaspin filter cleaning method (Bronk Ramsey *et al.* 2004) and an additional cleaning step where 90 °C water was used for pretreating ultra-filters. Further, samples with a laboratory number above UBA-24991 were pretreated using a simple ABA treatment followed by gelatinization and ultrafiltration with a Vivaspin filter cleaning method (Reimer *et al.* 2015). Samples have primarily been extracted from the mandible, but in one case a humerus and in three cases permanent teeth (one premolar, one lower first molar and one upper first molar) were used. The humerus was sampled on the distal diaphysis where bone is compact. Cortical bone was chosen for analysis since it is less likely to suffer from diagenetic change than trabecular bone. All mandibles and the humerus mirror the diet in the last ten years or so while the teeth reflect childhood diet (4–6 years for the first molar and 7–10 years for the premolar using Schour and Massler's dental development diagram available in Hillson 1996, 143). Even though it is possible that diet changes between childhood and adulthood there is nothing in the examined material to suggest such a change.

The radiocarbon dates and dietary isotopes of $\delta^{13}C$ and $\delta^{15}N$ have then been statistically analysed using one-way analysis of variance (ANOVA) to test the null hypothesis that there is no difference in diet between burial traditions during the LNII and the Early Bronze Age. The test was conducted using the data analysis package in Microsoft Excel with a significance level of =0.05.

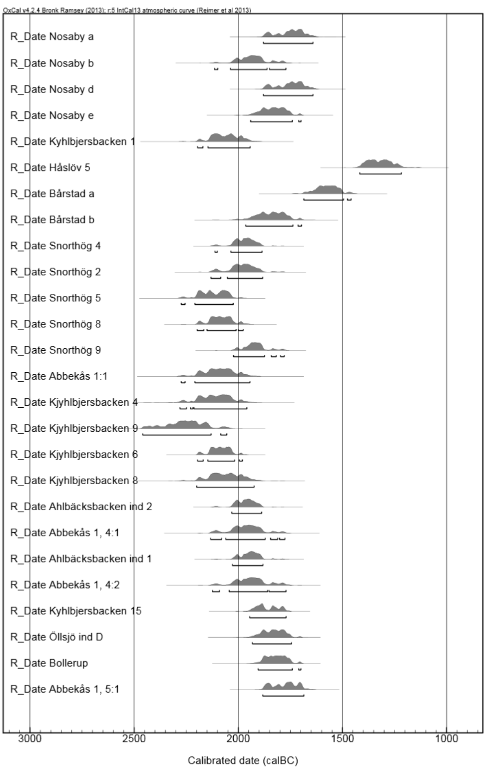
Since studies of dietary isotopes in collagen are poorly connected to the amount of carbohydrates ingested, additional studies of dental caries have been conducted. Dental caries is caused by acids produced by bacteria breaking down sugar. These acids can lead to the destruction of the enamel, dentine and tooth cementum, causing a cavity (Hillson 1996). There is a strong correlation between the amount of carbohydrates (especially sugars) and dental caries. There is evidence that caries frequencies increase in developing countries where the former dependence on starchy foods is replaced in part by refined sugars (Touger-Decker & van Loveren 2003). Gibson and Williams (1999) found a significant correlation between dental caries and the consumption of sugars in children living in Great Britain. However, they did not find a significant correlation between caries and other foods. The Swedish Vipeholm study, although conducted with ethically questionable methods, also found this correlation (Gustafson *et al.* 1954). The correlation between dental caries and starchy foods is complex. Modern examples show a low correlation between dental caries and carbohydrates other than refined sugar. However, there is a lack of dental caries among South Scandinavian hunter-gatherers, with increasing frequency in the Neolithic (Ahlström 2003). There are a number of similar observations all over the world (e.g. Cohen & Armelagos 1984; Wittwer-

Backofen & Tomo 2008). This suggests that there in fact is a correlation between dental caries and other carbohydrates than refined sugars in prehistoric societies.

Dental caries studies provide further insight into possible differences in diet not reflected by stable isotopes in collagen. Therefore, a total number of 598 post-canine teeth were included to evaluate dental caries frequencies. All teeth derive from the Scanian contexts that have been ^{14}C-dated to LNII and EBA included in this study, but not all teeth are associated with the individuals included in the stable isotope analysis. Dental caries was studied macroscopically under a bright light. Only cavities were recorded as present caries whereas opaque stains were recorded as absent. The location of caries was recorded as 0=no caries detected, 1=occlusal surface, 2=interproximal surface, 3=smooth surface (buccal, labial, lingual), 4=cervical caries (not interproximal regions), 5=root caries, 6=large caries, 7=non-carious pulp exposure, 9=not observable, as suggested by Buikstra and Ubelaker (1994).

The Late Neolithic – Bronze Age – burial traditions and complex identities

The radiocarbon dates of Late Neolithic and Early Bronze Age skeletons show that a typological dating of burials from this period is close to impossible. The burial tradition



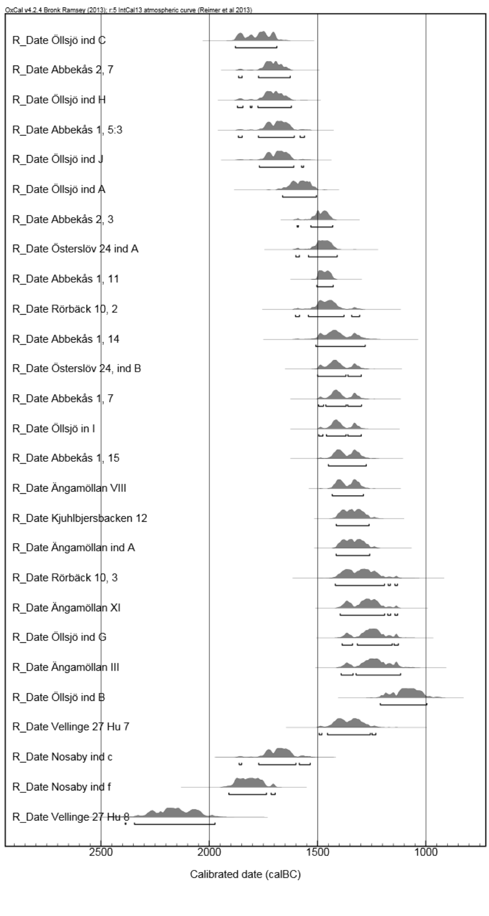


Fig. 2. Calibrated ^{14}C dates (cal BC) of Late Neolithic and Early Bronze Age graves in Scania. Calibration made using OxCal online.

seems to have been more complex than was previously thought. In this paper, these radiocarbon dates (Fig. 2) are provided and discussed in relation to social status.

The early part of the Late Neolithic seems to be an exception to the complexity inferred above. All of the graves (n=11) that have been dated to LNI (*c*. 2300–1950 BC) are inhumations in flat earth graves (Table I). Most graves hold only one inhumation, but there are also flat earth graves that have not yet been dated that include two or more inhumations. These might fall into the LNI span. There is a strong resemblance between burial customs in the early Late Neolithic and the pre-dating the Battle Axe Culture, regarding both burials in flat earth graves and the common crouching position of the buried. This is the dominant grave position at the Scanian site of Snorthög in Lilla Isie parish (Fig. 3), where a grave field from the early and late Late Neolithic is situated underneath a Bronze Age barrow.

Around 2000 BC people in Scania started to construct gallery graves; but the majority of burials in Scanian gallery graves seem to be dated to the Early Bronze Age (Table II). Some of the gallery graves, such as the Öllsjö gallery grave, have been rebuilt from Middle Neolithic passage graves. However, the custom of burying the dead in flat earth graves continues (Table I). Differing from the flat earth graves in the earliest part of the Late Neolithic is the custom of burying more than one individual in the

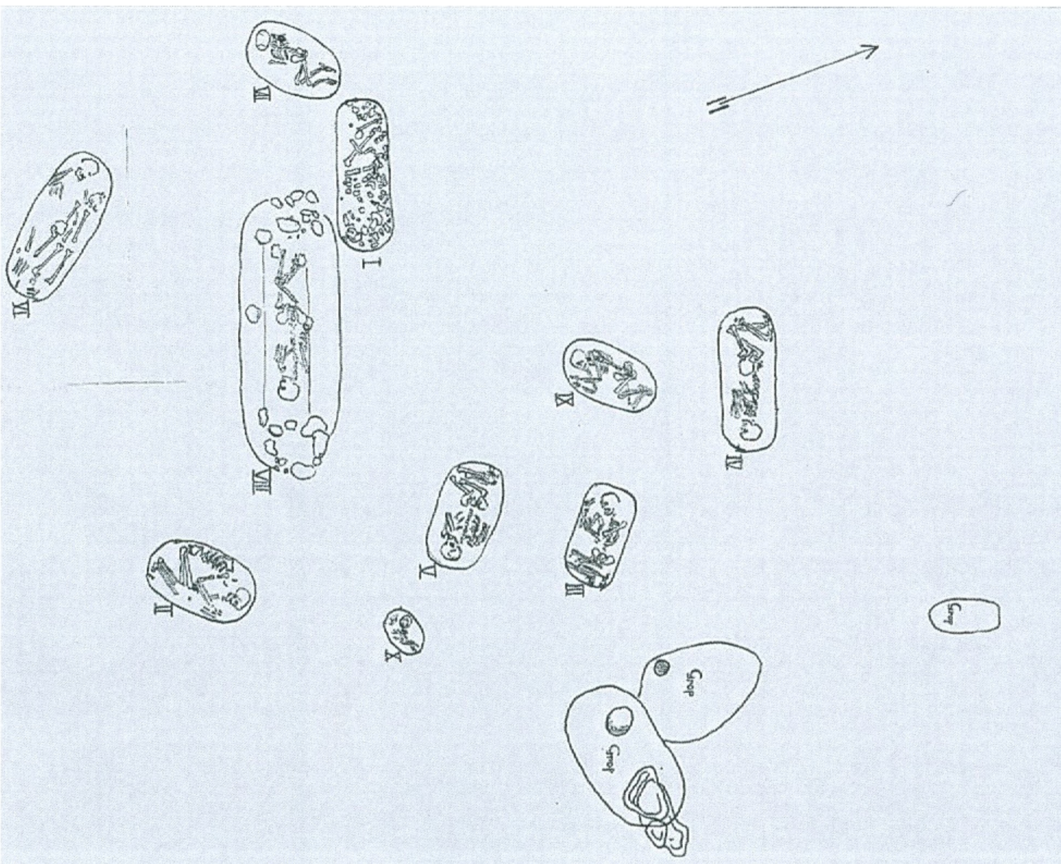


Fig. 3. The Late Neolithic burials of Snorthög, Lilla Isie parish.

Table I. Distribution of burial types in Late Neolithic-Early Bronze Age Scania, Southern Sweden. Radiocarbon dates made by Chrono laboratory, University of Belfast (UB and UBA) and the Department of Geology, Lund University (LuS). Dates are calibrated (2 sigma) using OxCal online.

	LN I				
Locality	**Burial Type**	**14C date BP**	**14C Date (cal.) BC**	**Lab no.**	**Sample material**
Kyhlbjersbacken 9	Flat	3805 ± 53	2460-2056	UBA_24002	Bone
Snorthög 5	Flat	3726 ± 35	2275-2025	UB_22851	Bone
Kyhlbjersbacken 4	Flat	3715 ± 50	2196-1981	LuS 10621	Bone
Abbekås 1, 1	Flat	3700 ± 50	2275-1945	LuS 10618	Bone
Kyhlbjersbacken 6	Flat	3697 ± 28	2196-1981	UBA_24000	Bone
Snorthög 8	Flat	3694 ± 32	2198-1977	UB_22852	Bone
Kyhlbjersbacken 8	Flat	3675 ± 50	2201-1925	LuS 10622	Bone
Snorthög 2	Flat	3616 ± 41	2132-1884	UB_22850	Bone
Snorthög 4	Flat	3608 ± 32	2113-1887	UB_22849	Bone
Vellinge 27, Hu 8	Flat	3748 ± 58	2389-1974	UBA_30561	Tooth root
Kyhlbjersbacken 1	Flat	3675 ± 40	2196-1944	LuS 11853	Bone
	LNII				
Locality	**Burial Type**	**14C date BP**	**14C Date (cal.) BC**	**Lab no.**	**Sample material**
Ahlbäcksbacken ind 2	Flat	3604 ± 30	2032-1889	UBA_24005	Bone
Abbekås 1, 4:1	Gallery grave	3600 ± 50	2134-1777	LuS 10619	Bone
Ahlbäcksbacken ind 1	Flat	3588 ± 30	2029-1882	UBA_24004	Bone
Abbekås 1, 4:2	Gallery grave	3585 ± 50	2125-1772	LuS 10620	Bone
Snorthög 9	Flat	3571 ± 32	2024-1780	UB_22853	Bone
Kyhlbjersbacken 15	Flat	3537 ± 28	1946-1771	UBA_24003	Bone
Öllsjö ind D	Gallery grave	3512 ± 35	1933-1745	UB_22855	Bone
Bollerup 4:1	Flat	3496 ± 32	1906-1700	UB_27863	Tooth root
Abbekås 1, 5:1	Flat?	3453 ± 35	1883-1686	UB_22837	Bone
Öllsjö ind C	Gallery grave	3453 ± 32	1880-1689	UB_22854	Bone
Nosaby ind f	Gallery grave	3491 ± 35	1910-1696	UBA_30560	Tooth root
Nosaby ind b	Gallery grave	3580 ± 45	2115-1772	LuS 11850	Bone
Nosaby ind e	Gallery grave	3510 ± 40	1941-1700	LuS 11852	Bone

	EBA				
Locality	**Burial Type**	**14C date BP**	**14C Date (cal.) BC**	**Lab no.**	**Sample material**
Nosaby ind a	Gallery grave	3535 ± 40	1880-1642	LuS 11849	Bone
Nosaby ind d	Gallery grave	3435 ± 40	1880-1642	LuS 11851	Bone
Abbekås 2, 7*	Barrow	3410 ± 30	1865-1627	UBA_22992	Bone
Öllsjö ind H*	Gallery grave	3408 ± 34	1871-1622	UB_22846	Bone
Abbekås 1, 5:3*	Flat?	3387 ± 38	1866-1561	UB_22840	Bone
Öllsjö ind J	Gallery grave	3385 ± 35	1769-1565	UB_22845	Bone
Öllsjö ind A	Gallery grave	3308 ± 32	1662-1506	UB_22842	Bone
Östersläv 24 ind A	Gallery grave	3204 ± 36	1601-1410	UB_27865	Tooth root
Abbekås 1, 11	Barrow	3197 ± 21	1504-1428	UB_22836	Bone
Rörbäck 10, 2	Barrow	3180 ± 45	1603-1306	LuS 10623	Bone
Abbekås 1, 14	Barrow	3144 ± 49	1509-1281	UB_22835	Bone
Östersläv 24 ind B	Gallery grave	3140 ± 39	1500-1299	UB_27864	Tooth root
Abbekås 1, 7	Barrow	3131 ± 33	1496-1298	UB_22841	Bone
Öllsjö ind I	Gallery grave	3130 ± 31	1495-1299	UB_22844	Bone
Abbekås 1, 15	Barrow	3111 ± 35	1451-1271	UB_22838	Bone
Ängamöllan VIII	Gallery grave	3105 ± 29	1433-1289	UBA_23998	Bone
Kyhlbjersbacken 12	Flat	3073 ± 28	1414-1263	UBA_24001	Bone
Ängamöllan ind A	Gallery grave	3070 ± 29	1415-1260	UBA_23997	Bone
Rörbäck 10, 3	Barrow	3045 ± 45	1419-1132	LuS 10624	Bone
Ängamöllan XI	Gallery grave	3025 ± 34	1396-1131	UBA_23999	Bone
Öllsjö ind G	Gallery grave	3011 ± 33	1387-1128	UB_22857	Bone
Ängamöllan III	Gallery grave	3004 ± 40	1392-1117	UBA_23996	Bone
Öllsjö ind B	Gallery grave	2899 ± 34	1211-996	UB_22843	Bone
Vellinge 27, Hu 7	Flat	3101 ± 46	1493-1232	UBA_30558	Bone
Nosaby ind c	Gallery grave	3381 ± 42	1863-1534	UBA_30559	Tooth root
Håslöv 5	Barrow	3060 ± 40	1418-1218	LuS 11854	Bone

The Flat? grave of Abbekås is referring to a grave with multiple burials outside a gallery grave.
*Dates suggest either LNII or EBAI.

same grave (all except Snorthög grave IX and Bollerup 4:1), even though single burials also existed simultaneously.

During the Early Bronze Age, especially from period II (c. 1500–1300 BC), an additional burial practice was present, the characteristic barrow. During the Early Bronze Age the complexity of burial traditions seems to culminate. During this period individuals are buried in flat earth graves (both single and multiple inhumations), in cairns, mounds and gallery graves. Most of the burials in the gallery graves actually date to the Bronze Age (68%) and not to the Late Neolithic (Table II). This differs from, for example, Västergötland in south-west Sweden, where only 29% of the gallery graves include Bronze Age burials at all (Blank 2016). Even though

Table II. Summary table of the frequency of the different burial types associated to the three studied periods.

	Flat earth	Barrow	Gallery grave
LNI	11	0	0
LNII	6	0	7
EBA	3	8	15

not present here, there are also possibilities of both Late Neolithic and Bronze Age reburials in passage graves. This is known from other parts of southern Sweden (Arne 1909; Blank 2016). The numbers of individuals from gallery graves and flat earth graves are fairly equal (20 and 22) whereas the number of individuals from moundsis only eight. This is a consequence of well-preserved skeletons from barrows not being as abundant as those from gallery graves and flat earth graves in this area. It seems as if the practice of inhumation in flat earth graves decreases while burials in gallery graves increase. There is no evidence of barrows being constructed earlier than in the EBA. The EBA spans over a larger time period than do LNI and LNII, and therefore a larger sample size is to be expected. However, the majority of burials derive from the first three hundred years, so the material might mirror a population increase during the period.

In the Late Bronze Age, the practice of cremating the dead dominated. However, cremations are known from both Middle and Late Neolithic contexts as well (Hansen 1937; Olausson 2015). No cremated remains have been integrated in this study, so there is a possibility that burial practices might have been even more complex than presented in this paper.

Targeting social stratifications and identities through dietary studies

It is evident that there exists a complexity considering burial traditions during the late part of the Late Neolithic (after 2000 BC) and especially in the Early Bronze Age in south Sweden. It is true that burial goods classically interpreted as high-status goods, such as different types of bronzes, seem more abundant in barrows than in flat earth graves or gallery graves from the same period (Håkansson 1985; Olausson 1993). This might well mirror different social strata through material culture. However, this is somewhat difficult to study since systematic observations only are known from barrows and flat earth graves, considering the previous lack of knowledge that gallery graves also include Bronze Age burials to such a large extent. Differences in social and economic status could also be revealed through bioarchaeological studies of health and diet.

A total of 29 individuals from the LNII and EBA were analysed for $\delta^{13}C$ and $\delta^{15}N$ to evaluate diet (Table III). All samples included had a C:N ratio between 2.9 and 3.5 as generally recommended (e.g. DeNiro 1985; van Klinken 1999). The range of the sample is -19–24.5‰ for $\delta^{13}C$ and 8.14–11.3‰ for $\delta^{15}N$. The mean of the $\delta^{13}C$ is -20.78‰ with a standard deviation of 1.29 and the mean of the $\delta^{15}N$ is 9.73‰ with a standard deviation of 0.76. The $\delta^{15}N$ mean value of 9.73‰ shows that these individuals were high up in the food web.

To evaluate whether there is a significant difference in diet between individuals inhumed in different burial types, one-way analysis of variance (ANOVA) was applied. The null hypothesis is that there is no difference in $\delta^{13}C$ and $\delta^{15}N$ values associated with burial custom. The sample of 29 individuals was distributed as in table IV.

Table III. The results of the stable isotope analysis. One sample was excluded from analysis since it did not fall within the recommended C:N range of 2.9-3.5.

Skeleton	**$\delta^{13}C$ (‰)**	**C At%**	**$\delta^{15}N$ (‰)**	**N At%**	**C:N ratio**	**Yield**
Snorthög 9	-24.5	24.70	8.91	8.80	3.27	11.7000
Abbekås 1, 5:1	-19.97	14.75	10.14	5.30	3.24	35.1000
Abbekås 1, 5:3	-21.2	12.75	9.44	4.65	3.21	19.6000
Abbekås 1, 15	-19.62	14.45	10.15	5.10	3.31	12.2000
Abbekås 1, 14	-19.89	12.30	10.38	4.40	3.24	26.8000
Abbekås 1, 7	-19.2	9.55	9.28	3.25	3.43	14.2000
Abbekås 1, 11	-20.87	11.70	9.28	4.20	3.25	20.9000
Öllsjö A	-22.2	7.80	8.14	2.60	3.47	15.9000
~~Öllsjö B~~	~~-23.5~~	~~7.25~~	~~9.57~~	~~2.35~~	~~3.55~~	~~15.0000~~
Öllsjö C	-22.5	24.60	8.75	8.95	3.20	11.8000
Öllsjö D	-19	37.15	9.22	13.50	3.22	2.4000
Öllsjö G	-22.2	13.05	9.73	4.50	3.35	4.4000
Öllsjö H	-21.4	20.75	9.39	7.55	3.20	13.5000
Öllsjö I	-21.9	16.25	8.24	5.70	3.33	9.4000
Öllsjö J	-23.5	32.35	9.12	11.40	3.31	1.9000
Abbekås 2, 7	-19.3	na	10.5	na	3.16	8.00
Ängamöllan 3	-20.4	na	9.5	na	3.30	3.30
Ängamöllan A	-20.1	na	10.1	na	3.22	0.90
Ängamöllan VIII	-19.8	na	9.9	na	3.22	1.20
Ängamöllan XI	-20.8	na	8.9	na	3.31	0.00
Kyhlbjersbacken 12	-19.9	na	11.3	na	3.17	5.10
Kyhlbjersbacken 15	-20.7	na	10.2	na	3.21	4.30
Ahlbäcksbacken 1	-21	na	9.9	na	3.29	13.90
Ahlbäcksbacken 2	-20.6	na	10	na	3.23	4.30
Nosaby ind. F	-19.8	na	10.7	na	3.17	15.40
Nosaby ind. C	-19.8	na	10.1	na	3.17	11.30
Vellinge 27, Hu 7	-20.4	na	10.8	na	3.45	10.90
Bollerup 4	-19.9	na	10.5	na	3.19	5.90
Österslöv 24, ind. a	-21.5	na	9.1	na	3.40	7.50
Österslöv 24, ind. b	-20.6	na	10.4	na	3.27	1.00

The ANOVA analysis showed that there is no statistical difference in either $\delta^{13}C$ or $\delta^{15}N$ values between individuals associated with different burials (Table V). The null hypothesis was therefore proven correct. The proportion of marine and terrestrial dietary reliance does not differ in any significant way between different burial traditions, nor does the proportion of meat consumption. Even though there is a difference in mean values between all burial types, the difference is not statistically significant. The gallery graves show the lowest $\delta^{15}N$ values and flat earth graves the highest, with barrows in between.

Table IV. The distribution of the sample. Isotope values are presented as mean values, standard deviations (SD) and coefficient of variation (CV %).

	Flat earth	Barrow	Gallery grave
$\delta^{13}C$ (‰)	-20.91	-19.78	-21.03
SD	1.4276	0.6694	1.2613
CV%	6.8	3.4	6
$\delta^{15}N$ (‰)	10.13	9.92	9.42
SD	0.7066	0.5958	0.7483
CV%	6.8	6	7.9
No. ind.	9	5	15

Table V. Statistics of the ANOVA showing no statistic difference in $\delta^{13}C$ values or $\delta^{15}N$ values between burial type in the LNII and EBA in Scania.

	$\delta^{13}C$	$\delta^{15}N$
F	1,980267	2,813493
F-crit	3,369016	3,369016
p-value	0,15831	0,078325

Note that these values do not correspond to the $\delta^{13}C$ values, that is, the highest $\delta^{15}N$ values do not correspond to the highest (least negative) $\delta^{13}C$ values reflecting a larger marine input. The isotopic values in the gallery graves, however, correlate well with each other, a high $\delta^{13}C$ value and a lower $\delta^{15}N$ value.

Since stable isotopes of collagen mainly reflect the protein contribution to the diet, dental caries was studied to reflect whether there was a high or low amount of carbohydrates in the diet. The percentage of dental caries differs between the burial types, especially between gallery graves and barrows. Gallery graves have the lowest percentage of dental caries (4.2% of 397 teeth), followed by flat earth graves (6% of 124 teeth). Barrows show the highest frequency with 9% of 109 teeth being affected (Table VI). Teeth are at unequal risk of developing dental caries. Incisors and canines are less frequently carious than are premolars and molars. To avoid bias in caries frequency due to this unevenness in risk, only post-canine teeth (premolars and

Table VI. The amount of dental caries in Scanian burials dated to LNII-EBA.

	Flat earth	Barrow	Gallery	Total
No. teeth	117	100	381	598
No. Caries	7	9	16	32
%	6	9	4.2	5.4

Table VII. Results of the Fisher' s Exact Test for Count Data of dental caries. The differences in caries frequencies are not statistically significant and could be due to sampling strategies. A=Flat earth, B=Barrows, C=Gallery graves.

	A-B		A-C		B-C	
	A	B	A	C	B	C
Observed	7	9	7	16	9	16
Total	117	100	117	381	100	381
***p*-value**	0.4499		0.4552		0.0818	
Odds ratio	1.5016		0.7024		0.4674	

molars) were selected for analysis. However, there are some differences in risk between post-canine teeth as well, possibly skewing the results if the representation is vastly different between burial types. Teeth with very severe caries or heavy attrition, leading to ante-mortem tooth loss, could not be included in this study, and could also bias the results somewhat. The amount of these types of teeth might also be unevenly distributed between different burial types, although there are no such indications visible in the data.

To sort out whether differences in dental caries were significant or could be a matter of sampling issues, Fisher's Exact Test for Counting was used. The test was conducted using the free statistical software R (r-project.org). The test is more restrictive than a traditional chi-squared test and not as sensitive to bias when dealing with small samples. According to the test, the differences in dental caries between different burial traditions were not statistically significant and could be the result of sampling strategies (Table VII). The largest difference in dental caries between gallery graves and barrows had a *p*-value of 0.0818. Therefore, it cannot be proven that there is heterogeneity in dental caries frequencies associated with burial tradition.

Discussion

It is evident that there is an increasing diversity and complexity in burial tradition from the early part of the Late Neolithic to the Early Bronze Age period II in Scania, southernmost Sweden. The burial tradition of the Middle Neolithic B, the Swedish-Norwegian Battle Axe Culture, seems to expand into the Early Late Neolithic. Flat earth graves, mainly single graves, dominate in the archaeological record, at least in Scania. Gallery graves were not constructed until around 2000 BC. These graves with multiple inhumations coexisted with single and multiple inhumations in flat earth graves. In the Early Bronze Age an additional burial type, the barrow, came into use. The increase in burial complexity could reflect an increase in social stratification or differences in group identities. Visible differences between social groups become important to upheld power. To investigate whether there were differences in dietary isotopes related to differences in burial tradition, a statistical analysis of ANOVA was applied. Diet was further analysed through the frequencies of dental caries, known to correlate with the amount of ingested carbohydrates.

The ANOVA showed that there was no significant difference in either $\delta^{13}C$ or $\delta^{15}N$. The $\delta^{15}N$ values were somewhat lower and $\delta^{13}C$ somewhat more negative in collective graves (i.e. gallery graves) than in flat earth graves and barrows, where individual inhumations were present, although both in single graves and in graves with multiple burials this might be the effect of sampling issues. The $\delta^{15}N$ values are generally high, with a mean value of 9.73‰. As high values might indicate that manuring was practised in Scania during the Late Neolithic (Bogaard *et al*. 2007; 2013). The analysis of dental caries showed that there were some differences in frequencies, but none were statistically significant. The difference in mean values between gallery graves with the lowest amount of dental caries and barrows with the highest amount had a *p*-value of 0.0818 (significance at p=0.05). Since differences in caries frequencies are not statistically significant it is possible that dental caries is a poor indicator of ingested carbohydrates or that the amount carbohydrates in the diet is homogeneous between individuals associated with different burial practice.

Apel (2005) thinks that the distribution of flint production places in relation to the finding places of flint daggers indicates a complexity and specialization during the Late Neolithic and Early Bronze Age. These centres are not at the same location. Further he suggests that complexity also is associated with a higher degree of division of labour. Increased division of labour is also necessary for a hierarchization of society. Different scholars argue that the introduction and distribution of metal are catalysts for this hierarchization process and therefore put it in the EBAIb or EBAII (Vandkilde & Northover 1996; Kristiansen 1999; Earle 2002). However, Apel (2001; 2005) argues that this process began already in the LN and was connected to the distribution of flint daggers.

The bioarchaeological evidence reflects tendencies more in favour of the latter, although towards the later parts of the period. There are changes in burial tradition starting with the BAC where a predominance of flat earth graves is evident. This change is consistent through LNI. This indicates that there is no difference in social hierarchy or group identity during the Early Late Neolithic, at least none that is reflected in the burial tradition. Further, studies of stature in Neolithic and Bronze Age southern Sweden show that there is an event of increasing male statures in the BAC that stays consistent throughout LNI (Tornberg in prep.). This might be related to changes in social settings and a higher degree of specialization already during the BAC; however, I argue that a more developed social stratification did not exist until later. Artursson (2005) argues that there was an increase in hierarchies beginning in LNI and culminating in EBAII, reflected in the variation in longhouse sizes. He also argues that there are tendencies for centre-periphery in south-western Sweden and in Zealand and Jutland already during the LNI. There are clusters of houses of various sizes, forming village-like settlements, in areas abundant in flint, where only scattered houses are present in more peripheral areas (Artursson 2005; Brink 2013). This gradual increase in social stratification is also reflected in the burial tradition showing a gradual increase in burial diversity, starting around 2000 BC, culminating in EBA II. This corresponds to events in central Europe where bronze production seems to have increased dramatically around 2000 BC (Vandkilde 2007, 95).

Håkansson (1985) concludes that it is probable that the differences in burial practice during the EBA in fact reflect differences in social status, and that the central grave in a barrow is the most prominent, followed by other burials in barrows, flat earth burials and lastly gallery graves. This assumption is further strengthened by the idea of the elite manifesting its power through individual and monumental burials while peasants rather depended on the collective for survival and social foundation. If the individuals in barrows represent higher social rank it is possible that a somewhat increased dental caries frequency is due to the ingestion of honey. The exploitation of the honeybee is known already from Early Neolithic contexts in continental Europe (Roffet-Salque *et al.* 2015) and it was used in southern Scandinavia during the Bronze Age. A honey-sweetened drink is known from the Early Bronze Age burial from Egtved, Denmark (Denmark National Museum). Drinking alcoholic beverages could be associated with some sort of feasting or ritual drinking among the elites. The feasting could have been a strategy to uphold power (Bradley 1984, 64).

This study confirms an increasing social stratification from at least LNII, with a culmination in EBAII. There is an increase in burial complexity throughout the Late Neolithic into the Early Bronze Age. It is probable that the increase in stature during the LNII–EBAII is also connected to this change in society. However, no difference in stature between different burial types during this period is evident, and therefore differences in health between different social status cannot be inferred (Tornberg, in prep.). It should also be stated that increasing stature also could be due to migrations, although this too is connected to the complex dawning society. There is no evidence of dietary diversity that could be associated with social status. Social stratification that is evident in the archaeological material does not show in the dietary record. It is possible that the view of the elite being more reliant on meat is not correct, and thus it is not reflected in the stable isotopes. If significant differences in the amount of dental caries could only be inferred when high amounts of refined sugar are ingested in modern examples, it might not be expected that a significant difference would be present between burial types in the Late Neolithic and Early Bronze Age. The caries frequencies still add to a low to moderate level.

Conclusion

It is evident that burial complexity increases from the early part of the Late Neolithic to the Early Bronze Age. New radiocarbon dates on individuals in graves that have previously only been typologically dated show that there were many burial traditions simultaneously in the province of Scania, especially during the Early Bronze Age. It is concluded that gallery graves were constructed after 2000 BC and used for a long period of time, at least into the EBA. The majority of the radiocarbon dates of gallery graves suggest Bronze Age burials. The diversity in burial practice is interpreted as coinciding with an increase in social diversity and a more hierarchic society where visible differences between the "elite" and "commoners" become important to upheld power.

The ANOVA show that there is no significant difference in diet associated with burial tradition. There are small differences in caries frequencies between the burial types, the difference between gallery graves and barrows being the largest, although not statistically significant. It is possible that traditional thoughts of high meat consumption among the "elite" are not valid during the Late Neolithic and Early Bronze Age. High values of $\delta^{15}N$, however, imply that manuring was practised in Scania during the Late Neolithic and Early Bronze Age.

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