DIET, GENDER AND RANK

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Abstract

The archaeology of rank is in many respects the basis for the study of social organisation in ancient societies. Here burial data are considered as closely related to the social position in life. Rank-indicating features marking social position can then be correlated with biological features such as sex, age, kinship, pathological traits, and dietary data, which are possible to study with scientific methods. This study concerns seven boatgraves at Tuna, Alsike parish, Uppland, Sweden, dating to the Vendel and Viking Periods. Molecular sex identifications, stable carbon and nitrogen isotope analyses, and trace element analysis were performed on human bones to gain information on the social structure of the population. No dietary hierarchy, and thus no gender differences, could be detected. However, since we now only have studied the upper stratum of the society, next study should concern the rest of the population. This is already underway since we believe this approach is fruitful for the study of archaeological rank and its implications.

Introduction

The archaeology of rank is in many respects the basis for the study of social organisation in ancient societies. Here burial data are considered as closely related to the social position in life (Keswani 1989). Rank-indicating features marking social position can then be correlated with biological features, such as sex, age, kinship, pathological traits, dietary data, etc. (Wason 1994).

A ranked society could be based on several categories, e.g. gender, age and inheritance, which are possible to study with scientific methods. Biological sex and age of skeletal remains are usually easily identified by the osteologist by different morphological characters. This is not always completely satisfactory, for example in those cases where not enough skeletal remains exist for proper identification, or where the individual is too young to be sexed by morphological means, or finally where the skeletal remains are cremated. In all these cases it is our belief that biological sex can be identified by the use of molecular methods (Götherström et al. 1997).

Once sex is identified it is possible to relate the different individuals to the archaeological context. By this it is possible to attribute different rank-indicating artefacts to sex and thus see if a gender-based hierarchy exists (Fig. 1). However, there are cases in which it is impossible to separate the rank-indicating objects or even where there are no artefacts deposited with the skeletons. In these cases the study of rank by means of diet is a possible solution.

Diet is a well-known indicator of rank and has as such been used in a number of archaeological studies (Bogan 1983; Price & Brown 1985; Huelsbeck 1988). Differences in access to specific resources or the amount of food are related to rank, e.g. proteins vs. carbohydrates (Schoeninger 1979; Hollimon 1992), or access to specific brewed liquids (Hastorf 1991).

Finally, our interest lies in whether the identified rank might be inherited or achieved. This is of importance e.g. in studies of the origin of the earliest states or kingdoms. It

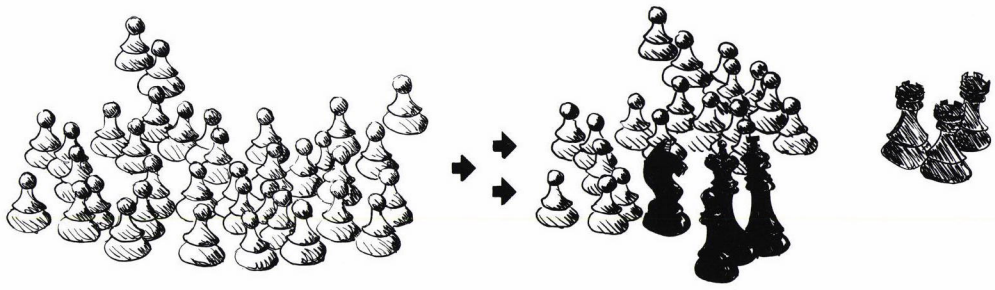

Figure 1. How the archaeology of rank can improve our knowledge of ancient societies. Drawing by Gunilla Eriksson.

has been proposed that it is possible to test whether rank is achieved or inherited by looking into the ratio of high-status male burials versus high-status female burials within a cemetery (Wason 1994). Another way of getting around this is to perform molecular analyses of kinship. This has been done concerning close relationships such as parent-child in Japan (Kurosaki et al. 1993), and has also been proposed for other kinship studies by Zierdt et al. (1996), who used alleles of short tandem repeat loci.

In this study we investigate burials from a boatgrave cemetery which is of interest to us in connection to the SIV (Svealand in the Vendel and Viking Periods) project. The SIV project aims to analyse and understand the power structure in central Svealand during the Vendel and Viking Periods, where one main goal will be to give a better insight into the mind and mentality of the period and especially to understand its aristocracy (Arrhenius & Herschend 1995). The project is characterised by a strong emphasis on a scientific analysis of the source material combined with an interpretation of the cultural history. This strategy forms the methodological base of the project and makes it unique within archaeology (Arrhenius & Herschend 1995).

Material and methods

Generally, we use inhumated skeletal remains in our studies, although it might even be possible to use cremated bones for DNA extractions (Götherström & Ovchennikov 1996). The seven bone samples in this study originate from the boatgrave cemetery in Tuna, Alsike parish, Uppland, dated to the Vendel and Viking Periods and excavated during the late 19th and early 20th centuries (Arne 1934). The site, situated at Lake Mälaren (Fig. 2), consists of 10–11 boatgraves of which two have been identified as female burials and the others as male burials (Müller-Wille 1970).

Since the bones had been pulverised some years earlier, for other purposes, we had to use a rather complicated extraction method in order to obtain any DNA. We first tried a slightly modified guanidium extraction on 0.5 mg of bone powder (Höss 1994). Here 1 µl of glycogen (20 mg/ml) was added to the sample during ethanol purification. This extraction did, however, not provide any DNA so we tried another extraction method. This time we used a phosphate extraction where approximately 0.5 ml phosphate buffer (2.5 M K_2HPO_4 neutralised to pH 7 with phosphoric acid) was added to the bone powder previously used in the guanidium extraction. The sample was then incubated at 60°C for 30 minutes and centrifuged. 300 µl of the supernatant was then added to an eppendorf tube containing 1.2 ml of wash buffer and 30 µl silica

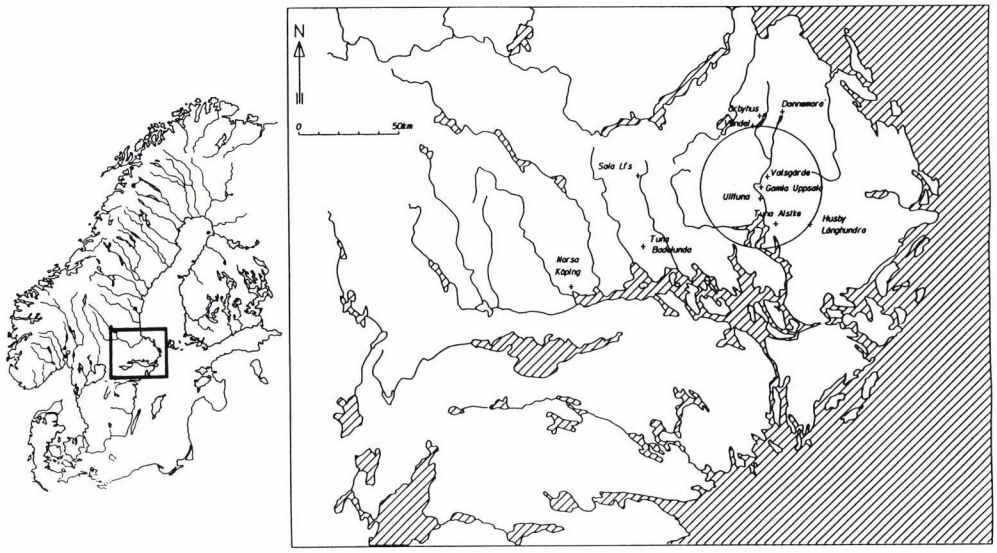

Figure 2. Map of Sweden with the study site Tuna in Alsike marked. Map by Kjell Persson.

suspension. The sample was washed once with wash buffer and twice with ethanol according to Höss (1994), with the addition of glycogen as mentioned above. In the following PCRs 10 µl of the extract was used. To conclude, the DNA extraction consisted of a guanidium treatment to break down the collagen in the bone as well as other present proteins (i.e. the guanidium extraction itself does not provide enough DNA), an extraction of DNA by a phosphate buffer, and finally purification by silica. We have noticed that this kind of phosphate extraction is a good method when dealing with a material rich in hydroxyapatite (Götherström & Lidén 1996).

The molecular sex identification was performed by the use of PCR and Y-specific primers. A Y-specific repeat unit was amplified and nested with the primers Y1, Y2, and Y3. The result was detected on a 3% agarose gel stained with ethidium bromide (Götherström et al. 1997). Since the bone had been pulverised previous to our handling, but had only been handled by females, we excluded the use of the X chromosome as a molecular sex marker. Consequently the amplification of an X marker would not provide any safe information of the analysed individual's sex – it would be impossible to exclude the risk of contamination. However, since no males had been in contact with the material after pulverisation, we thought it would be safe to use the Y chromosome as a positive molecular sex marker.

Collagen for isotope analysis was extracted according to Brown et al. (1988), where high-molecular remnants are selected for. The isotopes were measured using a Optima Fison mass spectrometer with a precision of <0.1‰, and are given as $\delta^{13}C = (R_u/R_s - 1) \times 1000‰$, where R_u and R_s are the respective $^{13}C/^{12}C$ ratios for the unknown and the standard (PDB limestone for carbon and AIR for nitrogen). Trace element analysis (Cu, Zn, Se) had been performed previously on this material by Birgit Arrhenius (Arrhenius 1990); the results will be discussed in connection with the results of the isotope analysis.

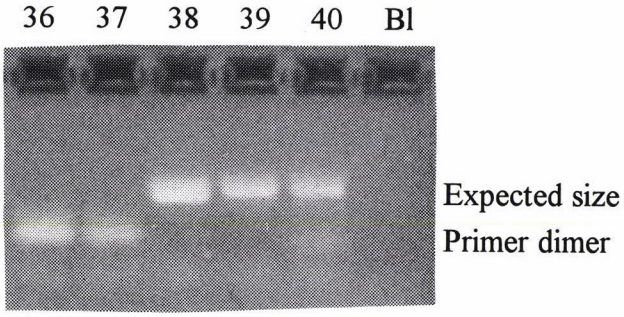

Figure 3. The second experiment. The samples were extracted and amplified with primer Y1, Y2, and Y3. The products were electrophoresed on a 3% agarose gel at 60 V for 30 minutes. Products were present in samples 38, 39, and 40. In the case of sample 35 there was not enough sample to repeat the experiment and in the case of sample 37 it did not amplify in the second experiment.

Results

All the samples, except for the blank, did amplify to some extent with the primers Y1/Y2. However, samples 38, 39 and 40 were the only ones to amplify with the nesting set Y1/Y3 (Fig. 3). This was also true when the extraction and the amplification was repeated. The result is not surprising regarding the high presence of fragmented DNA in the samples and the low specificity obtained with a low annealing temperature. In addition, the bones do not only contain human DNA but may also contain DNA from micro-organisms inhabiting the bone during the past thousand years (Brown & Brown 1992). All this provides advantageous conditions for PCR jumping and mispriming (Cooper 1992). To circumvent this we used the nesting procedure which makes the amplification more specific. All samples were run as double samples, except for samples 34 and 35 for which we had too little material. Sample 36 did not amplify with the nesting set, which means that we did not get a positive indication for the presence of a Y chromosome. In sample 37 we did get a positive amplification in one of the double samples, but it would not be repeated; thus we cannot with any great certainty say that we here have a male. To conclude the DNA analysis, it can only be stated with certainty that samples 38, 39 and 40 were males, whereas we cannot make any statements regarding samples 34, 35, 36, or 37 until we obtain new unpulverised bone (table 1).

Stable carbon isotope analysis and trace element analysis of the bones from Tuna have been published and discussed elsewhere (see table 1; Arrhenius 1990, Lidén & Nelson 1994); this time we added analysis of nitrogen isotopes and ran the carbon once again. The carbon results are in accordance with the previous results with a mean of –20.7‰ and a standard deviation of 0.5, as compared with the previous analysis –20.5‰±0.3. The carbon values clearly show that the input of marine protein to this population's diet must have been close to zero. The nitrogen values are all kept very close together at 13.9‰±0.5. The nitrogen values are all very high, indicating a diet originating from the very top of the food chain; they are actually so high that they implicate a rather large input of freshwater fish from the top of the food chain. Another interesting point here is the very low variation in the nitrogen values, which means that this population must have had a very equal diet regarding the protein intake.

Table 1. Osteological (Arrhenius 1990) and molecular sex identifications (# from Malmström 1995), stable isotope values in ‰ ($\delta^{13}C$* from Lidén & Nelson 1994) and trace element values in ppm (Arrhenius 1990), on the individuals buried at the boatgrave cemetery in Tuna, Alsike parish, Uppland.

Sample	Age	Ost. sex	Mol. sex	$\delta^{13}C$*	$\delta^{13}C$	$\delta^{15}N$	Cu	Zn	Se
Tuna III, **34**	Ad	M	?	–20.1	–20.1	14.0	16.1	184	2.7
Tuna XI, **35**	Ad	M	?	–20.8	–21.2	14.7	15.9	118	2.7
TunaVIb, **36**	Ad	F	F?#	–20.6	–20.9	13.4	–	99	3.7
Tuna IV, **37**	Ad	F?	M?	–20.5	–20.7	13.7	0.8	119	7.2
Tuna I, **38**	Ad	M	M	–20.8	–21.1	13.4	0.7	300	8.0
Tuna VII, **39**	Ad	M	M	–20.4	–20.1	14.1	2.5	161	5.1
Tuna VIII, **40**	Inf II	M	M	–20.2	–	14.3	1.0	129	2.9
Mean				–20.5	–20.7	13.9	6.2	159	4.6
S.d.				0.3	0.5	0.5	7.6	69	2.2

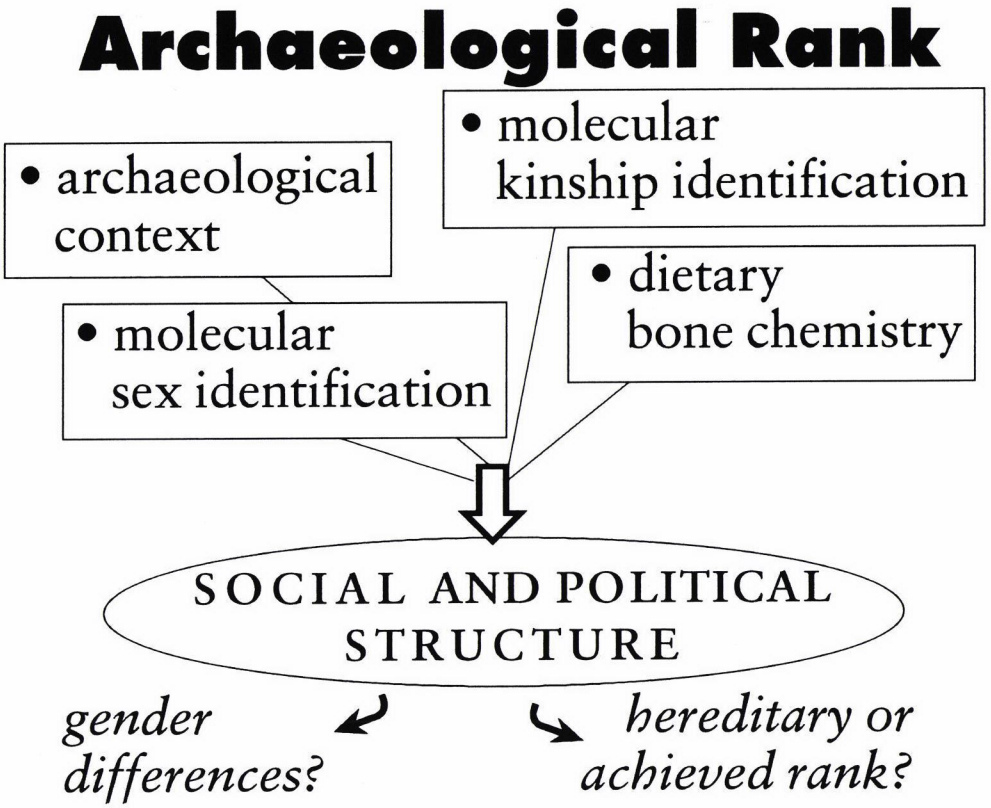

Figure 4. The way the authors interpret information of archaeological rank and how it can be utilised.

Discussion

The molecular analysis of the bone material emphasises the need for specific handling of the source material to enable certain scientific analyses. Molecular sex identification can, however, confirm archaeological and morphological sex identifications and

also in uncertain cases provide new information. As for example in sample 37, where the previous identification said *female?*, our results point towards a male – albeit with the material so far available also with a question mark. Our results also show the necessity to adjust the analytical procedure, i.e. the DNA extraction, for different circumstances.

In our specific application, the analysis of the bones from Tuna, it is interesting to notice the extremely low variation in both carbon and nitrogen isotope values, i.e. there is no difference between individuals in the access to protein resources. Accordingly, there seem to be no gender differences in this population, which judging by the prestige burials belongs to the upper stratum in the society. Studying the trace elements, however, we see that there are some distinguishing differences for example in copper and selenium. The deviating selenium values have previously been discussed as indication of trade northbound (Lidén & Nelson 1994). Sweden has naturally very low selenium soil content whereas meat from reindeers feeding on lichens have among the highest selenium values obtained in Sweden (*Livsmedelverkets tabeller* 1988).

To conclude our results from the Tuna analysis, we see that there are no dietary gender differences and thus no dietary hierarchy among the boatgrave individuals. However, since we now only have studied the upper stratum of the society, next study should concern the rest of the population. This is already underway since we believe this approach is fruitful for the study of archaeological rank and its implications (Fig. 4).

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