Osteologiske og paleobotaniske undersøkelser av skjelett og jordprøve fra Sverresborg, Trøndelag Folkemuseum, Trondheim, Sør-Trøndelag

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Sverressaga records that during the siege and destruction of Sverresborg in 1197, the body of a murdered birkebeiner was cast into the well of Sverresborg in order to poison the water supply and thus make the fortress uninhabitable. Excavation of the well in 1938 identified a skeleton at a depth of approximately 5 meters. The fate of the skeleton remained unclear, as excavators in 1938 did not record how it was treated. In 2014 it was decided to attempt to locate and remove the skeleton, if it still existed.

The skeleton was located and part of it removed (safety concerns prohibited the removal of the entire skeleton). The present report details the results of both an osteological analysis of the recovered boen material as well as a palaeobotanical analysis of a soil sample taken from the area around the abdomen of the skeleton and assumed to represent stomach contents at death.

The skeleton represents an adult male, between the ages of 30 and 40 when he died, with chronic back problems and early onset arthritis of the hip. Palaeobotanical analyses did not return any significant results.
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1. Osteological analysis of partial human skeleton recovered from a well at Sverresborg, Trondheim
Dr. Sean Denham
Arkeologisk Museum, Universitetet i Stavanger

1.1 Introduction
Saga literature records that in the wake of a battle in 1197 AD a dead body was thrown into the well of Sverresborg, a royal fortress in Trondheim, in order to poison the water supply. During excavations at Sverresborg in the 1930s, a human skeleton was identified in the well. It was assumed to be the remains of the body referred to in the saga literature. The records of the excavation (field notes, reports, newspaper articles) do not specify what happened to the skeleton, whether it was left in situ or removed. In advance of re-development of the site for tourist purposes, it was decided that an attempt should be made to locate the skeleton, if indeed it was still in the well. This process was complicated by two factors. First, while the excavation records do not indicate where in the well the skeleton was found. Second, massive amounts of modern material, as well as large boulders, have been thrown into the well over the past seventy years. The boulders, in particular, made excavation difficult.

The skeleton was found ca. 4-5m below the nearest edge of the well. Modern material, specifically German munitions, were located directly above the remains, and it appears that only a minor effort was undertaken to cover the skeleton after the 1938 excavations. Due to safety concerns, only part of the skeleton was able to be recovered. While this is not an ideal solution, it was the only one available. The rest of the exposed skeleton has been covered over and will hopefully be retrieved in the near future. The following report will detail the completeness of the skeleton (both those elements recovered and those left in situ but visible during excavation) as well as the results of an analysis of the recovered remains. Recording of demographic data follows the standards put forward by Buikstra and Ubelaker (1994).

1.2 Taphonomy/preservation
The skeleton is generally preserved to a high standard. It has been stained uniform dark brown color, presumably due to prolonged contact with the soil. There is damage to various facets of the recovered remains, although it is not great. Most of this can be attributed to either in situ damage or recovery processes. Great care was taken by the conservation staff at Vitenskapsmuseet, NTNU, to dry the elements very slowly, preventing further destruction of material.

1.3 Skeleton: position and completeness
Upon being thrown into the well, the individual came to rest on their right side, facing the side of the well. It was therefore the left dorsal aspect of the spinal column, rib cage, and pelvis which presented itself to excavators. While most of the remains appear to be in situ, the exposed left half of the rib cage has been disturbed. It has been suggested that this was done intentionally during the 1938 excavations in order to provide a more interesting photograph. Due to safety issues, it was only possible to expose the vertebral column up to the mid-thoracic vertebrae. It is therefore unclear how much of the upper body (upper thoracic and cervical vertebrae, clavicles, arms, should blades, and skull) remains. Photographic evidence suggests that the 1938 excavators were only able to uncover a similar amount of the skeleton. The exposed vertebrae and ribs, as well as the sacrum and pelvis were recovered. Upon removal of the pelvis, the heads of the left and right femora were visible. These clearly extend into an at-present inaccessible section of the well and give hope to the idea that the lower limbs (and by analogy the upper body) survive intact. During excavation the thoracic vertebra of a large mammal (e.g. reindeer, cow) was found in close association with the pelvis; some smaller animal remains were also recovered during sieving.
1.4 **Skeletal inventory: recovered elements**

Both halves of the pelvis, as well as the sacrum were taken up. The five lumbar vertebra as well as the lower five thoracic vertebra were also recovered. Four semi-complete ribs were recovered, as well as one smaller rib body fragment. Size and curvature suggest that these are not sequential ribs, supporting the idea that the ribs were disturbed for the purpose of photography during the 1938 excavations. Two second manual phalanges were recovered during sieving of the surrounding soil. Finally, one thin broken fragment of bone was recovered. It has been suggested that this is part of the mandible (Holck, pers. comm.), but this is not at all certain. The coloration of this fragment is inconsistent with that of the identifiably human remains. Appendix I provides a more detailed description of the completeness of the individual recovered elements.

1.5 **Sex estimation**

Both halves of the pelvis were used for identification of sex. Table 1 displays the results for the various sex indicators on the pelvis. The ventral arc, subpubic concavity, and the ischiopubic ramus ridge are scored on a three point scale: 1=female, 2=indeterminate, 3=male. The greater sciatic notch is scored on a five point scale, lower scores indicating female and higher scores indicating male. The pre-auricular sulcus is scored in a similar manner on a four point scale. The left half of the pelvis has damage to the greater sciatic notch and is missing the pubis symphysis, thus there is no data from these features. With the exception of the greater sciatic notch, which was given a score of 3 (indeterminate), all sex indicators fall into the male category. That the greater sciatic notch returned an ambiguous result is of no great concern, as this falls well within the range of natural variation for individuals of both sex. It can therefore be stated that this individual was almost certainly a male.

<table>
<thead>
<tr>
<th>Element</th>
<th>Side</th>
<th>Ventral Arc</th>
<th>Subpubic concavity</th>
<th>Ischiopubic ramus ridge</th>
<th>Greater Sciatic Notch</th>
<th>Pre-auricular sulcus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>R</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Pelvis</td>
<td>L</td>
<td>n/a</td>
<td>3</td>
<td>3</td>
<td>n/a</td>
<td>3/4</td>
</tr>
</tbody>
</table>

*Table 1. Sex estimation results for human remains from Sverresborg, Trondheim.*

1.6 **Age-at-death estimation**

Estimation of age-at-death is based on evaluating age-related change in the skeleton associated with either the growth/development, or the degradation of the skeleton. In the present situation the most relevant indicators of age are aspects of the pelvis, the surface of the pubic symphysis and the auricular surface. The surface morphology of these features changes over time and have been systems have been developed to equate specific morphological stages with specific age ranges (although there exists a certain amount of variability). Two separate scoring systems are used for estimating age from the pubic symphysis, the Todd system (10 point system) and the Suchey-Brooks system (6 point system). An eight point system is used to estimate age from the auricular surface. In all of these systems, lower scores indicate younger individuals, higher score indicate older individuals. As mentioned above, the left pelvis is missing the surface of the pubic symphysis, thus there is limited ageing evidence available from this element. Table 2 reports the results. The features tend to share morphological affinities with multiple categories, and have thus been assigned scores between these categories (e.g. 3-4, as opposed to 3 or 4). All of these scores may be associated with an age range of 30-40 years old at death.
1.7 Size estimation
It is not possible to estimate height from the recovered material. The slight gracility of the pelvis suggests an individual who was not overly robust. These points will become clearer when the rest of the skeleton is recovered.

1.8 Pathology
The vertebrae display a range of pathologies. Schmorl’s nodes, infections of the intervertebral disc which burrow into the articular surfaces of vertebral bodies, appear on the inferior and superior articular surfaces of first lumbar vertebra (L1) and continue on all subsequent vertebrae as one moves up the spine to the eight thoracic vertebra (T8). The number and depth of the nodes increases as one moves up the spine. The intervertebral disc between L3 and L4 is similarly infected and nodes can be seen on the corresponding articular surfaces. Similarly, heavy osteophytic development around the dorsal, superior margin of the L4 body, as well as the erosion of the surface adjacent to that margin suggest a back injury. This was first noted by Dr. Per Holck during his review of the material. Dr. Holck further suggests prolapse as the cause and estimates that such an injury may have occurred 5-10 years prior to death. L1-T11 show slight levels of compression. Exostoses appear to a greater or lesser extent on every vertebra. The neural arches of the thoracic vertebra show a particularly heavy development of exostoses. Taken as a whole, the recovered vertebrae tell the tale of a man who engaged in heavy physical activity, particularly lifting. This is somewhat at odds with the image of him as not particularly robust, but it may be more an issue of how and the frequency with which he was lifting rather than the actual weight. A range of symptoms may be associated with these pathologies, but none of them are inevitable. So he may have experienced chronic back pain or a range of neurological symptoms, or he may have experienced nothing. There is little pathological evidence present on the pelvis, although there is some slight evidence of the early development of osteoarthritis on the acetabula.

1.9 Summary
This is an interim report. If and when the rest of the skeleton is recovered our understanding of this individual will improve. Observations in the field as well as in the laboratory indicate a high probability that the rest of the skeleton survives, articulated and intact, in the well. It is unlikely that subsequent recovered material will change the present interpretations regarding sex and age-at-death (male, 30-40 years old), as the amount of evidence already available is overwhelming. Size estimates, both stature and robusticity, cannot be estimated from present material and require the remaining parts of the skeleton to be achieved. Initial pathological observations indicate numerous spinal conditions. Although none of these were necessarily problematic for the individual, it is highly likely that he experienced some symptoms associated with them.

1.10 References
### Appendix I. Identified species/elements and element completeness

<table>
<thead>
<tr>
<th>Element</th>
<th>Species</th>
<th>Side</th>
<th>Completeness</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic vertebra</td>
<td>Large mammal (e.g. equus, cervus, bos)</td>
<td>Axial</td>
<td>Complete</td>
<td>Vertebral plates unfused</td>
</tr>
<tr>
<td>Rib</td>
<td>Ovis (lamb)</td>
<td>Unk.</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Ovis (lamb)</td>
<td>Unk.</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Medium sized mammal</td>
<td>Unk.</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td>Homo sap.</td>
<td>Right</td>
<td>Complete</td>
<td>Pubic symphysis missing; greater sciatic notch partially damaged</td>
</tr>
<tr>
<td>Pelvis</td>
<td>Homo sap.</td>
<td>Left</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sacrum</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Part of S1 missing</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown</td>
<td>Unk.</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Vertebra (L5)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete (3 fragments)</td>
<td></td>
</tr>
<tr>
<td>Vertebra (L4)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Ventral facet of centrum partially eroded</td>
<td></td>
</tr>
<tr>
<td>Vertebra (L3)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (L2)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (L1)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (T12)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (T11)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (T10)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (T9)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Vertebra (T8)</td>
<td>Homo sap.</td>
<td>Axial</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Homo sap.</td>
<td>Left</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Homo sap.</td>
<td>Left</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Homo sap.</td>
<td>Left</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Homo sap.</td>
<td>Left</td>
<td>Partial</td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td>Homo sap.</td>
<td>Unk.</td>
<td>Partial</td>
<td></td>
</tr>
</tbody>
</table>
2. Radiocarbon dating results on human rib fragment from Sverresborg, Trondheim
Beta Analytic, Inc.

REPORT OF RADIOCARBON DATING ANALYSES

Ms. Anna Petersen
Norsk Institut for Kulturnerforskning (NIKU)

<table>
<thead>
<tr>
<th>Sample Data</th>
<th>Measured Radiocarbon Age</th>
<th>13C/12C Ratio</th>
<th>Conventional Radiocarbon Age(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betu - 344169</td>
<td>811 +/- 20 BP*</td>
<td>+7.3 PPM</td>
<td>810 +/- 30 BP</td>
</tr>
</tbody>
</table>

SAMPLE: TA2014-22
ANALYST: AMB (AMS-standard accuracy)
MATERIAL PRETREATMENT: (bone collagen) - collagen extraction with acid
2 SIGMA CALIBRATION: Cal AD 650 to 1150 (Cal BP 950 to 785)

Notes:
The conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. A 2 SD error interval where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*".
The Reporting Radiocarbon Age is for context purposes. When available, the Calibrated Radiocarbon result is determined from the Conventional Radiocarbon Age and is labeled as the "Two Sigma Calibrated Result" for each sample.
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C12/C13 = +17.3 oice : lab mutt = 1)

Laboratory number: Beta-364180

Conventional radiocarbon age: 14C ± 30 BP

2 Sigma calibrated result:
- Cal AD 1620 to 1155 (Cal BP 930 to 785)
- 95% probability

Intercept of radiocarbon age with calibration curve:
- Cal AD 1040 (Cal BP 655)
- Cal AD 1065 (Cal BP 630)
- Cal AD 1140 (Cal BP 510)
- Cal AD 1430 (Cal BP 150)

1 Sigma calibrated results:
- Cal AD 1030 to 1155 (Cal BP 920 to 750)

Database used:
INTCAL 13

References:

Beta Analytic Radiocarbon Dating Laboratory
4600 S.W. 18th Court, Miami, Florida 33145 • Tel: (305) 695-0367 • Fax: (305) 695-0368 • betadate@radiocarbon.com
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3. Marine reservoir correction and calibration of radiocarbon dating results
Dr. Sean Dexter Denham
Arkeologisk Museum, Universitetet i Stavanger

The need to correct for the marine reservoir effect in radiocarbon ages is well known. Differences in the rate at which carbon travels through the marine environment can cause radiocarbon dates based on carbon from the marine environment to appear younger than they actually are. The average difference is around 400 years. The method for correcting this involves calculating what percentage of the dated carbon is marine in origin, and how many years this equates to in terms of the average 400 year difference. There are local variations to this difference which should be taken into account if they vary significantly from the average (in the present case they do not).

In the present situation, the correction involves calculating the percentage of marine protein which comprised the individual’s diet. The δ13C value (the ratio of carbon-13 to carbon-12 in the sample), obtained as a byproduct of the radiocarbon dating via AMS, can be taken as a proxy of this value. A higher δ13C value indicates a higher percentage marine protein in the diet and vice versa. The calculation of percentage of marine protein in the diet is as follows:

\[ 100 \times \frac{(x - y)}{(z - y)} \]

where \(x\) is the measured δ13C value for the sample, \(y\) is expected δ13C value for a diet with no marine component (i.e. 100% terrestrial based diet), and \(z\) is expected δ13C value for a diet completely composed of marine based protein (i.e. 100% marine based diet) (Schulting, pers. comm.; Rasmussen et al., 2009). In this calculation, the values chosen of \(y\) and \(z\) are of critical importance, and various models have been suggested. For the present situation, two models are used as well as an average of these two. Table 1 presents the relevant information for the calculations as well as the results.

<table>
<thead>
<tr>
<th>Source</th>
<th>(x)</th>
<th>(y)</th>
<th>(z)</th>
<th>% marine diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>-17,3</td>
<td>-21</td>
<td>-12</td>
<td>41.1</td>
</tr>
<tr>
<td>Model 2</td>
<td>-17,3</td>
<td>-19,8</td>
<td>-10,9</td>
<td>28.1</td>
</tr>
<tr>
<td>Model 3 Average</td>
<td>Model 1 &amp; Model 2</td>
<td>-17,3</td>
<td>-20,4</td>
<td>-11,5</td>
</tr>
</tbody>
</table>

Table 3. Calculation of percentage of marine component in diet of individual recovered from Sverresborg, Trondheim

The conversion of these percentages into corrections for the marine reservoir effect as well as calibration/conversion of the corrected radiocarbon age into calendar dates was achieved using the CALIB program (Stuiver et al., 2015). Table 2 displays the results. As can be seen, the expected date of 1197 AD falls well within the 2σ ranges for all three models. There is, therefore, strong evidence to suggest that this individual is, in fact, the individual mentioned in Sverressaga as having been cast into the well during the siege of Sverresborg.
### Table 4.
Calibrated/marine reservoir corrected calendar ages, based on three separate models for calculation of percentage marine diet, for human remains recovered from Sverresborg, Trondheim.

<table>
<thead>
<tr>
<th>Model</th>
<th>Conventional radiocarbon age BP</th>
<th>cal Calendar age AD (2σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>940 ± 30</td>
<td>1190-1285</td>
</tr>
<tr>
<td>Model 2</td>
<td>940 ± 30</td>
<td>1154-1268</td>
</tr>
<tr>
<td>Model 3</td>
<td>940 ± 30</td>
<td>1170-1273</td>
</tr>
</tbody>
</table>

#### 3.1 References


4. Paleobotanisk rapport Sverresborg

Sara Westling
Arkeologisk Museum, Universitetet i Stavanger

En makrofossilprøve ble tatt ut fra mageregionen av skjelettet fra brønnen på Sverresborg.

4.1 Analyse av makrofossil

Prøvens volum var ca. 100 ml og 50 ml ble tatt ut til analyse. Prøven ble våtsiktet og fraksjonert på sikter med maskevidde 1 mm, 0,5 mm og 0,25 mm. Den ble siden sortert og oppbevart i vann. Preparering og sorting ble utført av Tamara Virnovskaia. Til både sorting og analysearbeidet ble stereolupe med forstørrelse 7,5x til 112,5x brukt.


Både usorterte planterester og restmaterialet etter sorting er tatt vare på med tanke på eventuell senere utnyttelse til analytiske formål og som en mulig kilde til forskning innen norsk paleobotanikk, miljøhistorie og landskapsutvikling i framtida. 50 ml av prøven gjenstår også ubehandlet.

4.2 Resultat

Alle frø var uforkullete. Det ble også funnet fragmenter av trekull, plantestengler, brente og ubrente bein og meitemarkkokonger. En større ubrent beinbit var også i prøven. Den ble tatt om hand av Dr. Sean Dexter Denham og inkludert i den osteologiske analysen.

<table>
<thead>
<tr>
<th>Norsk navn</th>
<th>Latinsk navn</th>
<th>Antall frø</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linbendel</td>
<td>Spergula arvensis</td>
<td>3</td>
</tr>
<tr>
<td>Vassarve</td>
<td>Stellaria media</td>
<td>2</td>
</tr>
<tr>
<td>Fiol, uspesifisert</td>
<td>Viola</td>
<td>2</td>
</tr>
<tr>
<td>Marikåpe, uspesifisert</td>
<td>Alchemilla</td>
<td>1</td>
</tr>
<tr>
<td>Krekling</td>
<td>Empetrum nigrum</td>
<td>1</td>
</tr>
<tr>
<td>Starr, trekanta nøtt</td>
<td>Carex tristigmaticae</td>
<td>4</td>
</tr>
<tr>
<td>Starr, flat nøtt</td>
<td>Carex distigmaticae</td>
<td>2</td>
</tr>
<tr>
<td>Gress, uspesifisert</td>
<td>Poaceae</td>
<td>2</td>
</tr>
<tr>
<td>Ikke identifisert frø</td>
<td>Varia</td>
<td>7</td>
</tr>
</tbody>
</table>

Tabell 5. Frømateriale fra prøver tatt fra Sverresborg.

4.3 Tolkning

Blant frømateriale i funnet er det kun krekling som framstår som en mulig matplante. Den er dokumentert på boplasser fra steinalder og oppover og er omskrevet også i kulturhistoriske kilder (Høeg 1976, Henriksson 1978). Linbendel og vassarve er åkerugress som kan ha blitt spist sammen med dårlig rensket korn men de er også vanlig forekommende på annen mark og kan ha vokset i
området rundt brønnen. Starr, gress, marikåpe og fiol har sannsynligvis ikke vært del av mageinholdet men har vokset i eller rundt brønnen.

Prøven inneholdt også en del sand og silt og det er tydelig at det ikke er snakk om rent mageinhold. Skjelettet har ligget relativt ubeskyttet i brønnen i lang tid og sannsynligvis har frø og annet fra omgivelsene blitt vasket ned gjennom jordmassene og blandet seg med mageinholdet og det som allerede lå på bunn når det havnet der.

4.4 Litteratur
Katz, N. Ya., Katz, S.V. & Kipiani, M.G. 1965. Atlas and keys of fruits and seeds occurring in the Quaternary deposits of the USSR. Nauka, Moskva. 365 s (Russisk tekst)