Molecular vs. osteological sex determination in cattle

Confirmation of osteological methods by ancient DNA analysis

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SUMMARY

Metapodials are often used in identification of sex in cattle from osteoarchaeological assemblages. Metacarpals are more likely to show sexual dimorphism than metatarsals due to the fact that the fore extremities carry most of the animals live weight. **The breadth measurement of the distal trochlea is generally considered as an easy way to determine the sex.** The oxen/bull trochleas are broader than the ones from cows, and the male bones often show asymmetric due to the effects of higher loading in combination with draught labour. **We wanted to investigate the reliability of this method for sexing by developing a DNA test for sex determination in cattle. This test confirms the osteological sexing in 20 cases out of 26, the remaining 6 individuals could not be typed (*tab. 1*).**

Fig. 1 *The bones randomly selected for the analysis.*

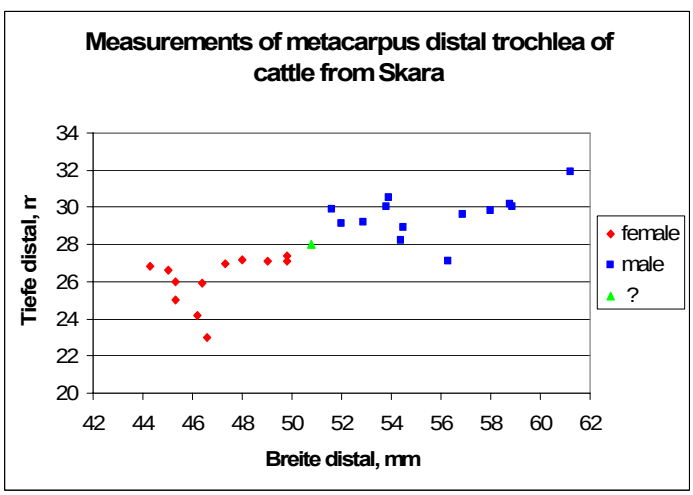

Fig. 2. *The cows gather in the lower left corner of this diagram showing distal breadth and width of metacarpals. Trochleas broader than 52 mm are identified as oxen/bulls.*

MATERIAL

26 distal metacarpal ends from the 12th-13th centuries, found in the medieval town of Skara in Western Sweden, were randomly chosen for this study (***fig. 1***). Traditional morphological sex identification, gave the result that 12 bones were from cows, 13 from oxen/bulls and 1 were not possibly to identify to sex with this method (***fig. 2***, ***Table 1***).

Table 1. *Results obtained from osteological and molecular sex determination*

Specimen nr	Bd[a]	Td[b]	Sex[c]	Genotype[d]
1	56,9	29,6	male	A/G
2	49	27,1	female	A/A
3	46,4	25,9	female	A/A
4	52	29,1	male	*
5	47,3	27	female	A/A
6	49,8	27,1	female	A/A
7	46,2	24,2	female	*
8	49,8	27,4	female	A/A
9	56,3	27,1	male	A/G
10	53,9	30,5	male	*
11	58,8	30,2	male	A/G
12	61,2	31,9	male	A/G
13	58	29,8	male	A/G
14	45	26,6	female	*
15	48	27,2	female	*
16	52,9	29,2	male	A/G
17	58,9	30	male	A/G
18	53,8	30	male	A/G
19	46,6	23	female	A/A
20	51,5	29,9	male	*
21	45,3	25	female	A/A
22	44,3	26,8	female	A/A
23	45,3	26	female	A/A
24	54,4	28,2	male	A/G
25	50,8	28	?	A/A
26	54,5	28,9	male	A/G

♂ **A/G**

♀ **A/A**

a *Breite distal, measurement in mm*

b *Tiefe distal, measurement in mm*

c *Sex determined based on Bd and Td values*

d *Result from the DNA test*

**No result could be obtained*

MOLECULAR SEX DETERMINATION IN CATTLE

The DNA test was based on the ZFX/ZFY system[1]. A single nucleotide polymorphism (SNP) differentiates between males and females. Both females and males have an A at their X-chromosomes, but the males have a G instead of an A on their Y-chromosome[2]. Primers were designed to be cattle specific but also work on aurochsen. Approximately 100mg of bone powder is needed for the analysis which was performed as in (3) using the Pyrosequencing technique[TM,4].

CONCLUSIONS

Molecular sexing confirms the robustness of the osteological criterion used for sex determination.

This simple DNA test for sex identification can be used for example when bones suitable for osteological analysis can not be found. Or when no conclusive result can be obtained through measurements.

The use of a SNP for sexing gives several advantages. Only short DNA fragments needs to be analyzed and a result is obtained both for males and females.

AKNOWLEDGEMENTS

This work was supported in part by stipends to E. Svensson from Helge Ax:son Johnssons fund, and Birgit and Gad Rausings fund for humanistic research.

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