

Highlights of Analytical Sciences in Switzerland

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The Beginnings of Alpine Transhumance? Isotopic Insights into Neolithic Cattle Herding

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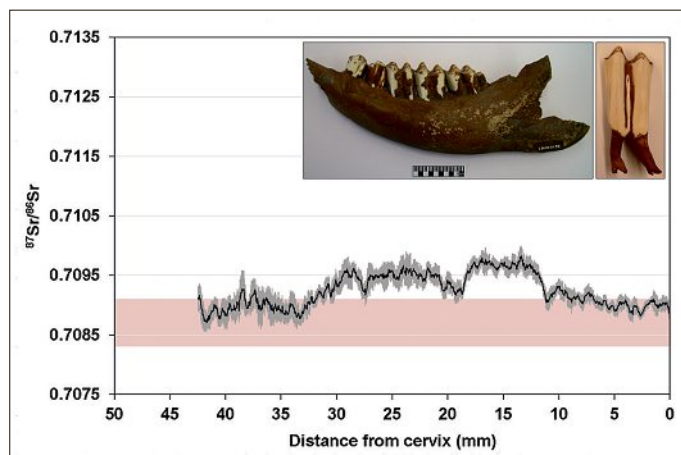
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The Neolithic period marks the initiation of sedentary lifestyles in central Europe and animal husbandry becomes one of the key elements of human society. In (sub)alpine environments, the development of the animal economy is tightly linked to the advent and rise of transhumance, *i.e.* the seasonal translocation of animals to grazing grounds above the timber line. The latter implies wide-ranging economic and social consequences.

To investigate early cattle husbandry and animal mobility in the Neolithic wetland sites of Switzerland, we applied strontium isotope analysis ($^{87}\text{Sr}/^{86}\text{Sr}$) to solid tooth enamel samples. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in the tooth material reflect the $^{87}\text{Sr}/^{86}\text{Sr}$ of the geological environment and feeding grounds during different life periods of individual cattle. In order to obtain samples at the spatial and hence temporal resolution required to identify seasonal movements of cattle, we employed laser ablation (LA) inductively coupled plasma mass spectrometry (ICP-MS). A homogenized Ar-F 213nm laser with a spot size of 120 μm , fired at 10 Hz, is focused on the sample, which is then ablated continuously, while it is moved in the growth axis of the tooth. The ejecta are swept into the MS, where the Sr isotope ratio ($^{87}\text{Sr}/^{86}\text{Sr}$) is determined.



Alpine cattle economy (Photo: J. Schibler).



5400 year old cattle mandible, second molar extracted for strontium and carbon isotope analysis (Photo: C. Gerling) and $^{87}\text{Sr}/^{86}\text{Sr}$ cattle mobility pattern 2 (seasonal movement) at the Neolithic wetland site of Arbon Bleiche 3, Lake Constance (Gerling *et al.* *PLoS ONE* 2017, 12, e0180164, Fig. S1, Detail).

This allows many hundreds of analyses per cm of tooth, and in turn the assessment of Sr isotopic composition variations at a very high temporal resolution.

The combination of carbon and high-resolution strontium isotope analyses provided conclusive evidence for transhumance in the Neolithic. We were able to distinguish between three concurrent patterns of animal mobility and husbandry in the settlement of Arbon Bleiche 3 at Lake Constance (middle 4th Millennium BC), which suggest differential access to grazing resources: 1) localised cattle herding, 2) seasonal movement, and 3) herding away from the site year-round. We argue that the densely forested environment created pressure on local fodder capacities, making alternative herding strategies (*i.e.* transhumance) necessary. As a consequence, cattle had an increasing importance in the local landscape and were likely to have contributed to the progress of socio-economic differentiation in early agricultural societies in Europe.

The combined application of new and established analytical techniques thus provides high-resolution insights into prehistoric subsistence economies and people's way of life.

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