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Alpine cattle management during the Bronze Age at Ramosch-Mottata, Switzerland

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ABSTRACT

Based on a series of new radiocarbon dates we examine the vertical mobility of cattle in the Alps by means of strontium isotope analysis on samples from the prehistoric settlement of Ramosch-Mottata (Canton of Grisons, Switzerland). By identifying variations in the strontium isotope ratios of high-crowned cattle molars, we investigate the seasonal use of alpine pastures (vertical transhumance) and changes in cattle husbandry practices between the early and later stages of the site's occupation. Combined with the evidence of multiple high-altitude sites, indications of dairying and ethno-archeological observations, we see an economic shift and a reorganization of domestic animal exploitation from the early to the late Bronze/early Iron Age in the Alps.

1. Introduction

Nothing seems more natural in the Central European Alps than using the widespread high meadows for pasturing sheep, goats, cattle and horses in the summer months. Lush grassland, grazing animals, aromatic mountain cheese – many elements of the local alpine culture originated a long time ago and still characterize Switzerland's identity today, although implying a distorted picture of the social reality (Weiss, 1992). The question of the beginnings of alpine summer farming has long been discussed (Frödin, 1940; Gleirscher, 1985, 2010) and the debate has gained new momentum particularly in the past 25 years, fueled by the discovery of the Tyrolean Iceman Ötzi. This icon of alpine archeology and best manifestation of early vertical mobility (Egg and Spindler, 2009; Kutschera and Müller, 2003; Lippert et al., 2007; Oeggl et al., 2007, 2009), has repeatedly been associated with "vertical transhumance" (Spindler, 2005). However, despite extensive surveys over the past 25 years, no tangible archeological evidence has been found to support this idea (Gleirscher, 1997; Festi et al., 2014; Putzer and Festi, 2014; Putzer et al., 2016). Nevertheless, archeobiological surveys (Moe and van der Knaap, 1990), single finds at high altitudes and field name research have substantially contributed to the indexing of prehistoric alpine pastoralism in Switzerland. These works have provided a more detailed record of the various incentives that have driven humans up into the mountains for millennia, i.e. the sourcing of raw materials, trans-alpine trade and transport, hunting and gathering, conflicts, religion and pastoralism (Curdy et al., 2003; Curdy, 2007; Moe et al., 2007; Hess et al., 2010; Reitmaier, 2012; Patzelt, 2013; Alther, 2014; Walsh et al., 2014; Fedele, 2015; Giguet-Covex et al., 2014; Hafner, 2015; Schwörer et al., 2015).

Pastoralism is a distinct form of human subsistence in which domestic animals play a predominant role in the shaping of the economic and cultural lives of the people who depend on them. It is both a land use strategy and a system of animal production. There is a (world-)wide spectrum of different forms of pastoralism, due to a range of factors that can include the quantitative and qualitative characteristics of herds, the extent and range of mobility, the type of agricultural products, environmental and ecological aspects of

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the region and the extent of ties with an external market (Arnold and Greenfield, 2004; Arnold et al., 2013). The seasonal vertical movement of livestock between pastures at different altitudes is a highly specialized economic system and its adoption has important implications for a community's social-political structure, practices and cultural ideology in marginal highlands (Greenfield, 2010).

Few regions in Europe are as strongly associated with pastoralism and alpine animal husbandry as the Swiss-Austrian mountains. The question as to whether cattle were already being pastured on alpine meadows in the Engadine region, Switzerland, in the 2nd and 1st millennia BC was first asked more than 30 years ago. In her pioneering study on prehistoric sites in the Lower Engadine, Stauffer-Isenring (1983, 128) called for systematic research of prehistoric herding. Over the past 10 years various researchers have responded to this call by launching an interdisciplinary study on the development of alpine animal husbandry in the Silvretta Alps (Switzerland/Austria; Reitmaier et al., 2013). The Silvretta mountain range is located in the central eastern Alps and stretches across an area of c. 770 km^2. This region remained completely devoid of any archeological evidence until 2007, when systematic surveys started to reveal more than 200 archeological sites covering a period of 11 millennia. Amongst them a large number of high-alpine features (above 2000 m a.s.l.) were discovered. Besides the Mesolithic and Neolithic sites (Cornelissen and Reitmaier, 2016), a considerable number of Bronze Age structures are of particular interest with regard to the question of livestock and pastoral economy. They suggest that alpine pastures were used from the late 3rd millennium BC onwards (Reitmaier, 2012). Palynological and paleoethnobotanical analyses highlight a distinct increase in human and domestic animal impact, with a fundamental transformation of the landscape at the transition to the 2nd millennium BC (Dietre et al., 2014, 2016; Kothieringer et al., 2015). Apophytes and spores of coprophilous fungi are clear indicators for pasturing on alpine meadows during the Bronze Age and hint at grazing pressure. Particularly important in relation to alpine pastoralism are the first permanent buildings to emerge in the Silvretta Alps, from the early 1st millennium BC onwards. Three dry-stone structures were identified as an alpine hut (Fimba Valley/Val Fenga, 2283 m a.s.l.) and the remains of cattle/sheep pens (Fimba Valley/Val Fenga, Las Gondas, 2360 m a.s.l.; Tasna Valley/Val Tasna, Plan d'Agl, 2060 m a.s.l.). They were dated by radiocarbon measurements on charcoals from pits (Table 1, site no. 6, 8 and 10) and by typological assessment of ceramic finds, indicating that they were used during the late Bronze/early Iron Age (Reitmaier, 2012, Fig. 10). The pottery suggested both a chronological and a functional connection between the high-altitude structures and settlements in the valley (e.g. Ramosch-Mottata, 1517 m a.s.l.; Ardez-Suotchastè, 1521 m a.s.l.; Guarda-Muot Pednal, 1696 m a.s.l.), which implies repeated long-term stays in the alpine pasture areas, with food supply and food production. This is supported by biochemical analyses of late Bronze and early Iron Age pottery attesting to local processing of milk and indicating a fundamental change in alpine animal husbandry (Carrer et al., 2016). All these lines of evidence suggest an established seasonal valley-alp system, as known from historical sources (Weiss, 1992).

An important part of such a system is the vertical movement of livestock to high-altitude meadows in summer and lowland pastures in winter. Isotopic analysis offers a systematic approach to investigating animal management and herding systems in general (e.g. Pearson et al., 2007; Knipper, 2011; Henton, 2012; Makarewicz and Tuross, 2012) and to tracing faunal mobility in mountain regions in particular (Valenzuela et al., 2016). A useful and well-established method is strontium (Sr) isotope analysis, in particular when measured by high-resolution laser ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS). Sr isotope analysis is based on the fact that strontium isotopes, i.e. the ratio of ^{87}Sr to ^{86}Sr, vary according to geology, i.e. to differences in the age and composition of the bedrock (Faure and Powell, 1972; Ericson, 1985). Due to processes of erosion, the characteristic $^{87}Sr/^{86}Sr$ signature of the local geology is passed on to soil and plants and then via the food chain to animals and humans (Bentley, 2006). It is incorporated into hard tissues such as tooth enamel, where it substitutes calcium in the hydroxyapatite mineral. This happens at the time when enamel is formed in growing animals, and this $^{87}Sr/^{86}Sr$ signature does not substantially change later (Julien et al., 2012). Enamel is relatively resistant to physical and chemical contamination due to its composition (Zazzo et al., 2005; Burton, 2008), although the degree of enamel diagenesis is unclear and has lately been under discussion (e.g. Zazzo, 2014). Nevertheless, cattle tooth enamel is a good proxy for the locally distinct Sr signal of the underlying geology where the animal was grazing at the time of tooth formation and tooth enamel mineralization. Cattle have high-crowned (hypsodont) teeth, which form sequentially from the cusp of the crown to the cervix (Hillson, 2005). Second permanent molars (M2) in cattle mineralize between the ages of approximately 1 month and 12/13 months, while third permanent molars (M3) mineralize from the age of 9/10 months to 23/24 months (Brown et al., 1960; Beasley et al., 1992). Hence, sampling of the second and third permanent molars of cattle provides isotopic insight into the first two years of the animals' lives. However, the growth rate of tooth enamel is probably non-uniform and there may be alternating periods of faster and slower enamel growth (Bendrey et al., 2015). Moreover, the isotope information available may cover a shorter period than two years, depending on the degree of tooth abrasion, which is subject amongst other things to the environmental conditions, the age of the animal at death and its fodder (Grant, 1978).

This paper examines mobility patterns of Bronze Age cattle in the Alps by applying Sr isotope analysis to samples from the prehistoric settlement of Ramosch-Mottata (Canton of Grisons, Switzerland). Our research focuses on i) the identification of variations in the Sr isotope ratios of high-crowned molars suggesting seasonal changes of pastures and ii) the identification of chronological changes in cattle husbandry practices between the early and later stages of the site's occupation.

2. Environmental and archeological setting

Ramosch-Mottata is located in the Lower Engadine Valley in the Canton of Grisons, Switzerland (Fig. 1). The altitude of the valley bottom varies between 1015 m a.s.l. at Martina in the east and 1475 m a.s.l. at Zernez in the west. The valley is shaped by the River Inn and surrounded by mountains reaching altitudes of 3400 m a.s.l. but easily accessible from different directions. A number of prehistoric settlements in the Lower Engadine have been excavated, albeit by amateurs and at a rather early date. The oldest sites dated from the early and middle Bronze Age (c. 2200-1350 BC) and were more or less continuously occupied until the late Iron Age (c. 400-15 BC). An interesting cultural phenomenon in this area is the "Laugen-Melaun" group (Stauffer-Isenring, 1983; Gleirscher, 1992) which began to emerge in the early phase of the late Bronze Age (Bz D/Ha A1; c. 1350-1130 BC) and is interpreted as representing immigration from Northern Italy.

The hilltop settlement of Ramosch-Mottata (1517 m a.s.l.) has a very distinct position in the prehistoric cultural landscape of the Lower Engadine. Discovered in the 1950s and partially excavated in several campaigns (Frei, 1959), the site was the starting point for the systematic search for seasonal economic activities in the upland's prehistory. The permanent settlement is characterized by its location near terraced fields, highly suitable for farming (Raba,

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