Journal of Archaeological Science 40 (2013) 4039–4055

Contents lists available at SciVerse ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Seasonality and season of birth in early Eneolithic sheep from Cheia (Romania): methodological advances and implications for animal economy

Carlos Tornero [a,*], Adrian Bălăşescu [b,2], Joël Ughetto-Monfrin [a,1], Valentina Voinea [c,3], Marie Balasse [a,1]

[a] Archéozoologie, Archéobotanique – Sociétés, Pratiques et Environnements, UMR 7209 CNRS/MNHN, CP56, 55 rue Buffon, 75005 Paris, France
[b] National Museum of Romanian History, Calea Victoriei nr.12, Sector 3, 030026 Bucharest, Romania
[c] The National History and Archaeology Museum, Piata Ovidiu nr.12, 900745 Constanta, Romania

ARTICLE INFO

Article history:
Received 20 February 2013
Received in revised form
15 May 2013
Accepted 16 May 2013

Keywords:
Stable oxygen isotopes
Tooth enamel bioapatite
Sheep
Seasonality of birth
Season of birth
Hamangia culture
Early Eneolithic
Romania
Cheia

ABSTRACT

Cheia (early 5th millennium cal BC) is a prehistoric village in the Dobrodgea province in Romania. Its occupation is attributed to the Early Eneolithic period or Hamangia III phase. The exploitation of animal resources is heavily dominated by husbandry. Although cattle are dominant, they were complemented by caprines, mainly sheep, exploited for tender meat (as highlighted by a 6–12 months age class peak in the mortality profile). Sheep reproduction patterns were investigated through stable isotope analyses in order to characterize the annual rhythms of slaughtering for tender meat acquisition while informing a more general picture on sheep demographical management and animal husbandry at the settlement. Results from $\delta^{18}O$ analysis on second and third molar enamel were modeled and compared with modern reference populations. Sheep births took place over less than four months, from late winter to early summer. From this it could be concluded that tender meat could be provided most of the year, excepted over short period in early summer. Finally, comparison of datasets obtained on the M2 and M3 suggests that the M2 presents a more accurate representation of birth seasonality due to lower inter-individual variability in the chronology of tooth growth.

1. Introduction

1.1. Presentation of the site and research objectives

Cheia (early 5th millennium cal BC) is a Neolithic village in the central hills of the Dobrodgea province in Romania, close to the Casimcea River. Its occupation is attributed to the Hamangia culture and more precisely to the Hamangia III phase (5000–4700 cal BC) or Early Eneolithic. The Hamangia refers to the first food producing communities to settle in the area comprised between the Danube River and the Black Sea in Romania. It was extended up to north-eastern Bulgaria, where the most important recovered site is the cemetery of Durankulak (Todorova, 2002). Neighboring sites to Cheia include Tîrguşor "Urs", La Izvor, Baba, Casian caves, Techirghiol, Cernavoda, Baia-Hamangia, Ceamurlia de Jos and Golovita (Fig. 1). Little is know about exchanges between Hamangia communities and coexisting cultures (Boian, Precucuteni and Marica). However, the presence of Hamangia clay figurines and fine pieces of *Spondylus* beyond the Danube river in north-eastern Muntenia and southern Moldova has been interpreted by some authors as existence of intercultural links (Marinescu-Bîlcu et al., 1995; Voinea et al., 2009).

The site of Cheia was excavated over a surface of 585 square meters, representing approximately 1/5 of the total extension of the settlement. The stratigraphic sequences have revealed a pattern of periodic occupation, with permanent habitat along the year, probably over years to decades, interrupted by abandonment phases long enough to lead to the destruction of deserted dwellings. Different dwellings have been documented during extensive excavation, revealing the scattered character of the settlement and a successive recurrence of habitat by communities. Household refuse areas have been documented during excavation and faunal

* Corresponding author. Tel.: +33 (0)1 40 79 33 15, +33 (0)1 40 79 48 82; fax: +33 (0)1 40 79 33 14.
E-mail addresses: ctornero@mnhn.fr, carlostornero@hotmail.com (C. Tornero), abalasescu2005@yahoo.fr (A. Bălăşescu), ughetto@mnhn.fr (J. Ughetto-Monfrin), vialia_rahela@yahoo.fr (V. Voinea), balasse@mnhn.fr (M. Balasse).
[1] Tel.: +33 (0)1 40 79 48 82; fax: +33 (0)1 40 79 33 14.
[2] Tel.: +40 21 315 82 07; fax: +40 21 311 33 56.
[3] Tel./fax: +40 241 618763.

0305-4403/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jas.2013.05.013

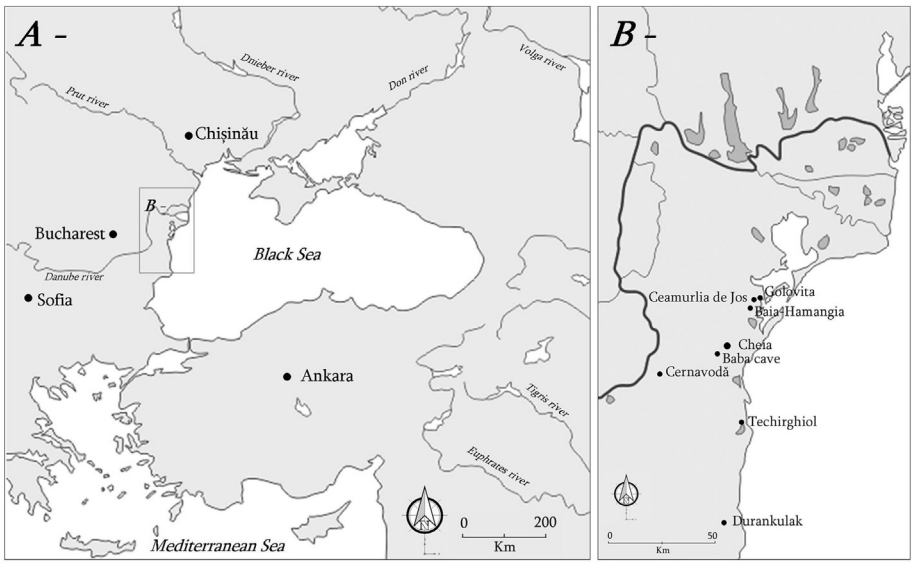

Fig. 1. Map of the location of Cheia and key surroundings archaeological sites mentioned at text.

remains were one of the most important category of materials recovered (Voinea and Dobrinescu, 2002–2003; Voinea and Neagu, 2006; Voinea et al., 2006/2007; Voinea and Neagu, 2008).

Archaeozoological analyses documented an exploitation of animal resources heavily dominated by husbandry complemented by hunting and the foraging of resources from the river (Bălăşescu and Radu, 2003, 2004; Bălăşescu, 2008; Radu, 2008). Although Cheia is situated approximately 14 km west of the Black Sea coast, very few marine remains in the assemblage, including six remains of *Cardium*, three remains from a large size *Rutilus* and sturgeon (NR = 26), which may as well have come from the Danube river have been recovered, and interpreted as a little economical exchanges with Hamangia communities settled by the littoral (Radu, 2008). Animal husbandry is characterized by a dominant exploitation of cattle complemented by caprines, among which sheep dominate over goats. The caprines' mortality profile constructed from the dental remains retrieved from the stratigraphic unit (SU) 3094 (Number of teeth: 240) is very strongly structured, with an over-representation (68.7%) of individuals belonging to Payne's (1973) age class C, slaughtered at between 6 and 12 months, suggesting emphasis on tender meat production (Bălăşescu, 2008). Because this age class is restricted in time, this peak of slaughter could also correspond more or less to a seasonal activity, if the birth distribution pattern of caprines was seasonally restricted. Seasonality of birth (*i.e.* the pattern of distribution of births, unimodal or bimodal, restricted or extended), as well as the season of birth, remains to be demonstrated at the site.

The objective of this study is to investigate the seasonal reproduction patterns of sheep through stable isotope analysis. This information could help to characterize the annual rhythms of slaughtering for tender meat acquisition, while informing in a more general picture of sheep demographical management and animal husbandry at the settlement. Moreover, the exceptional faunal assemblage recovered at Cheia, with a large collection of well-preserved hemi-mandibles, also offers possibilities for methodological research on the investigation of birth season and birth seasonality through sequential stable isotopes analyses of tooth enamel. Using both second and third molars from each individual, we tested the reproducibility of conclusions from the analysis of both teeth and compare the amplitude of inter-individual variation in the timing of tooth growth for each molar. Finally, the results obtained on the Cheia assemblage are compared to several published modern references in order to determine the season of birth.

1.2. Seasonal reproduction patterns from oxygen isotopic signatures

Stable oxygen isotope ratios ($\delta^{18}O$) from tooth enamel bioapatite are linked to the $\delta^{18}O$ of drinking water and plant water ingested by animals. Oxygen in bioapatite precipitates in isotopic equilibrium with body water after fractionation and species-specific physiological and metabolic influences (Longinelli, 1984; Luz et al., 1984; Kohn, 1996; Kohn et al., 1996; Iacumin and Longinelli, 2002). The water source is directly related to meteoric water for terrestrial mammals and its isotopic composition is affected by climate, including seasonality. At high and middle latitudes the $\delta^{18}O$ of precipitation varies with ambient temperature during the seasonal cycle: warmer meteoric water results in higher $\delta^{18}O$ values and cooler meteoric water results in lower $\delta^{18}O$ values, although other factors (source of evaporated water, amount and timing of precipitation) can also influence this scheme (McCrea, 1950; Dansgaard, 1964; Gat, 1980; Rozanski et al., 1993; Kohn and Welker, 2005). Seasonal variations in the $^{18}O/^{16}O$ ratio from meteoric water are then recorded in $\delta^{18}O$ values of enamel bioapatite over tooth formation (Fricke and O'Neil, 1996; Sharp and Cerling, 1998).

Teeth in mammals are formed from the crown apex to the cervix during short-term periods of time (from months to years according to the tooth and species). Sequential or serial sampling of tooth enamel allows the reconstruction of sequential isotopic values through the tooth mineralization process. Particularly for hypsodont or high-crowned species, this serial sampling can provide a detailed record of seasonal variations in enamel stable isotope ratios during a short time period of the life of a single animal on an infra-seasonal scale (Balasse, 2002, 2003). As the timing of tooth growth and enamel formation is fixed at the specific level, cyclical seasonal variations of $\delta^{18}O$ values tend to fall at approximately the same position of tooth crown in individuals born at the same time of the year.

A large number of studies investigating seasonality of birth have involved sequential analyses of $\delta^{18}O$ values from tooth enamel: Bryant et al. (1996a,b) on fossil equine teeth, Fricke and O'Neil (1996) on modern bovine teeth and Kohn et al. (1998) on modern East African Grant's gazelle specimens tested the first approaches and method guidelines. More recently, this approach had been extended