Charles University

Faculty of Arts

Department of Archaeology

Archaeology of Prehistory and Middle Ages

Propositions for PhD thesis

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Mobility of individuals and populations in the prehistoric period. Confrontation of archaeological, ethnological and natural scientific methods.

Mobilita osob a populací v předhistorickém období. Konfrontace archeologických, etnologických a přírodovědných metod.

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Introduction

The topic of human mobility is not only popular in discussions of contemporary societies but owing to the rapid development of various natural scientific methods also in archaeological research. The trend, sometimes called "the third science revolution in archaeology" (Kristiansen 2014), began with the study of genetic and phenotypic data (e.g., Ammerman and Cavalli-Sforza 1984) and increasingly the use of biogeochemical analyses based on the study of the isotope compositions (e.g., strontium, oxygen and lead) of biological tissues (Brown and Brown 2011; Laffoon et al. 2017; Slovak and Paytan 2011). These methods, unlike traditional archeological approaches based on the spatial distribution of material culture, can provide more direct evidence about the movement of populations and individuals from the analyses of their skeletal and non-skeletal remains.

Since the spatial movement of people can be studied from many different perspectives (Table 1; cf. Cabana and Clark 2011; Ortman and Cameron 2011) and several basic types of mobility can be recognized (Table 2), the present thesis is not, and cannot be, a comprehensive review of past human mobility. It is just an attempt to address selected problems.

Research presented in this thesis consists of three case studies which illustrates the range of the topic. In Case Study 1, the advantages and limits of multiple-tooth strontium isotope analysis are critically assessed. In Case Study 2, the association between post-marital residence and dwelling size is tested using phylogenetic comparative analysis methods and a global sample of 86 pre-industrial societies. In Case Study 3, we combine various types of evidence (archaeological, strontium and ethnographic) to determine post-marital residence patterns in the Early Neolithic of the Central European temperate zone.

Table 1. *Perspectives of mobility.*

	Mobility	
Scale	**Individual < > Community < > Supra-community***	
Distance / Duration	short - long	long
Boundaries	internal - external	external
Frequency (*regularity)*	one-time - repetitive (*regular / irregular*)	long-term process
Permanency	temporary - permanent	migration stream
Intention	voluntary - forced	

*tribes, nations, species.

Table 2. *Types of mobility from different perspectives.*

Mobility	Scale	Distance *Duration*	Boundary	Frequency *(regularity)*	Permanency	Intention
Everyday	I	S	I	R / I	T	V
Residential	I	S / L	I / E	O / I	P / T	V / F
Subsistence	SG / C	S / L	I / E	R / I	T	V
Travelling	I / SG	S / L	I / E	O / R / I	T	V
Raids and captive taking	SG / C	L	E	O / R / I	T (raiders), Γ / P (captives)	V (raiders), F (captives)
Fission and colonization	SG	L	E	O / I	P	V / F
Whole-community migration	C / SC	L	E	O	P	V / F

Legend: *Scale*: I = Individuals, SG = small groups, C = communities, SC = supra-communities. *Distance*: S = short, L = long; *Boundary*: E = external, I = Internal; *Frequency*: O = one-time; I = irregular repetitive, R = regular repetitive; *Permanency*: T = temporary, P = permanent; *Intention*: V = voluntary, F = forced.

CASE STUDY 1. Childhood mobility revealed by strontium isotope analysis: a review of the multiple tooth sampling approach

Strontium isotope analysis of archeological skeletal materials is a highly effective and commonly employed analytical tool to investigate past human mobility and migration (Bentley 2006). Most such studies to date have focused on the analysis of a single tooth sample per individual to identify migration. Increasingly, however, studies have analyzed multiple teeth from the same individual permitting the detection of migrations occurring during childhood, more fine-grained temporal resolution of the age at which migration(s) occurred, and even the identification of multiple migration episodes (e.g., Buikstra et al. 2004; Evans et al. 2006; Hadley and Hemer 2011; Hedman et al. 2018; Knipper 2009; Knipper et al. 2018; Weber and Goriunova 2013).

Tooth enamel forms in the early years of human life and is not remodeled afterwards (Hillson 1996). Moreover, the age of formation of different teeth is variable per tooth type (element) and is relatively consistent within and between populations (AlQahtani et al. 2010). Differences in strontium isotope ratios between teeth formed at different ages can therefore be an indication for residential change during childhood or adolescence.

We compiled and analyzed published $^{87}Sr/^{86}Sr$ data for 1043 individuals from 122 sites to explore the potential variability of childhood mobility patterns cross-culturally. We created

three tooth categories: 1) *Early* (including deciduous teeth, incisors, canines and permanent first molars; and corresponding approximately with the ages of 0-3 years); 2) *Middle* (premolars and permanent second molars; corresponding with the ages of 3-8 years); and 3) *Late* (third molars; corresponding with 8-14 years of age).

The most common tooth pairs compiled are Early-Late (n = 700), followed by Early-Middle (340) and Middle-Late (285), with some individuals represented by multiple pairs. Most individuals (around 66% or 77% depending on the tooth pair) possess very small offset between two paired teeth (smaller than 0.0005) suggesting residential stability during their childhood. As could be expected, the reported $\Delta^{87}Sr/^{86}Sr$ variability differs significantly between different regions and time periods. While individuals at some sites exhibit consistently low $\Delta^{87}Sr/^{86}Sr$ values, for example, in prehistoric and late antique Southeastern Arabia, other individuals have very large differences between two teeth, for example, those buried during colonial era (18^{th}-19^{th} centuries) in Cape Town, South Africa. There are also differences between tooth pairs across sites and regions, indicating that people moved during different periods of their childhood.

Although the analyzed dataset has clear spatial and temporal biases and is lacking in representativeness, this study has revealed several important findings. The reported $\Delta^{87}Sr/^{86}Sr$ variability differs significantly between different regions and time periods. This cannot be explained only by different patterns of subsistence or by diverse geological conditions around each site, and thus must reflect to some extent different patterns of childhood mobility in the past. These include residential change of whole family, fosterage, herding activities, post-marital residence rules, or forced migrations.

Previous applications of the multiple tooth sampling approach for strontium isotope studies of human paleomobility have clearly demonstrated that childhood mobility was more common than previously recognized. The increasing number of studies utilizing this approach in recent years perhaps illustrates a renewed interest in social (e.g., age-related) variation in patterns of human migration and mobility, as well as methodological advances permitting higher resolution reconstruction past lifeways and life histories. Nonetheless, the various limitations of the multi-tooth sampling approach, well as (single) isotope analysis in general, merit more explicit consideration.

The extent of identified childhood mobility will generally remain an under-estimation, since it is usually impossible to reveal mobility between two places with similar bioavailable $^{87}Sr/^{86}Sr$ signatures. Therefore, it is beneficial to supplement this method, when possible, with other isotopic proxies, for example, multiple tooth $\delta^{18}O$, $\delta^{15}N$ and $\delta^{13}C$ analyses or other

archaeological methods. Of course, childhood mobility can be also revealed by analyzing isotope ratios in the remains of children themselves (i.e., of individuals who died during childhood, as opposed to tissue samples from adults which form during childhood). Such an approach permits the identification of child migrants that did not survive to adulthood (Hadley and Hemer 2011: 72). Conversely, isotope analysis of certain deciduous teeth that form solely or primarily *in utero*, could in principle be used to investigate the mobility/migration patterns of mothers during pregnancy.

As nuanced interpretations cannot be deduced from multiple tooth $^{87}Sr/^{86}Sr$ analysis alone, because every outcome can be explained in several different ways, the results should always be placed within an appropriate archaeological, historical and ethnographic context. In order to reveal dietary/residential changes at finer temporal resolutions it is preferable to analyze teeth from three age categories (e.g., first molar, second molar, third molar). The incorporation of four or more permanent teeth does not provide much additional information in this respect, since the formation ages of many teeth overlap. By contrast, the multiple tooth sampling approach involves significantly higher investments in time and costs than the traditional single tooth sampling approach, and it also destroys a larger amount of archaeological material, since the strontium isotope analysis is a destructive method, as is the case with most types of biochemical analysis of human remains. As such, decisions about which sampling approach to employ will likely be influenced by these practical considerations, as well as the specific contexts of the individual case studies. Therefore, analysis of multiple tooth should be conducted only in cases where there is a justified assumption that the results will provide new and meaningful findings.

CASE STUDY 2. Identifying post-marital residence patterns in prehistory: A phylogenetic comparative analysis of dwelling size

The decision regarding who will leave home after marriage and who will stay with their own kin affects many important aspects of social organization (Peoples and Bailey 2011), including descent systems and kinship terminology (Murdock 1949), wealth inheritance rules (Agarwal 1988), modes of marriage (Divale and Harris 1976), community size (Korotayev 2004), division of labor (Korotayev 2003), migration (Divale 1974), and warfare (Ember 1974; Ember and Ember 1971).

Identifying post-marital residence (PMR) patterns in prehistoric societies is challenging, however, since they leave almost no direct traces in archaeological records. Cross-cultural researchers have attempted to identify correlates of post-marital residence through the statistical

analysis of ethnographic data. Several studies (Brown 1987; Divale 1977; Ember 1973; Porčić 2010) have demonstrated that, in agricultural societies, large dwellings (over ca. 65 m2) are associated with matrilocality (spouse resides with or near the wife's family), whereas smaller dwellings are associated with patrilocality (spouse resides with or near the husband's family).

However, these studies suffer from several methodological issues. First, they only considered two types of PMR: matrilocal and patrilocal. Second, they did not control for the non-independence of societies due to common ancestry. Third, except the presence of agriculture in Porčić's study (2010), they did not considered other aspects that could impact dwelling size.

In this case study, we re-examine the association between the average house floor area (AHFA) and PMR using a different sample of 86 societies, revised AHFA values, and a finer continuous variable that captures all types of PMR. Our analysis includes additional explanatory variables, specifically the presence of agriculture, fixity of settlement, and house construction material, while controlling for non-independence using a time-calibrated phylogenetic supertree of human populations based on genetic and linguistic data (Duda and Zrzavý 2016, 2019).

The previous sample compiled by Porčić (2010) was geographically imbalanced, consisting mainly of closely related American societies that shared a common ancestor no more than 16,000 years ago (Llamas et al. 2016). Our results confirm that these societies are indeed not statistically independent. In our study, all variables except AHFA showed a non-random (although relatively low) phylogenetic signal.

The single best predictor of AHFA is the fixity of settlement (Fig. 1B); mobile populations prefer to live in small, easy to build houses. Agriculture, when coded as a binary trait ("not important" or "important"), was found to have a positive association with AHFA, as has been previously documented (Porčić 2010), but this association loses significance once the fixity of settlement is included into the model. Construction material was not found to be significantly associated with AHFA.

Our analysis confirms the cross-cultural association between house size and post-marital residence is valid. It applies to a broad range of post-marital residence patterns (not only to strictly matrilocal or patrilocal residence) and remains significant after controlling for other explanatory variables (agriculture, fixity of settlement and construction material) and phylogeny. The association between house size and post-marital residence is not absolute, however; specifically, societies with very large houses (over ca. 200 m^2) are not associated with any particular type of residence (Fig. 1A). In these societies, one household usually consisted

of multiple families, and it can be assumed that such large units were more resistant to dissolution due to disputes between individuals, than smaller households consisting of only two or three families. In a larger household, there were more mediators and authorities who could settle a dispute. Moreover, leaving of one family did not led to disintegration of the entire household.

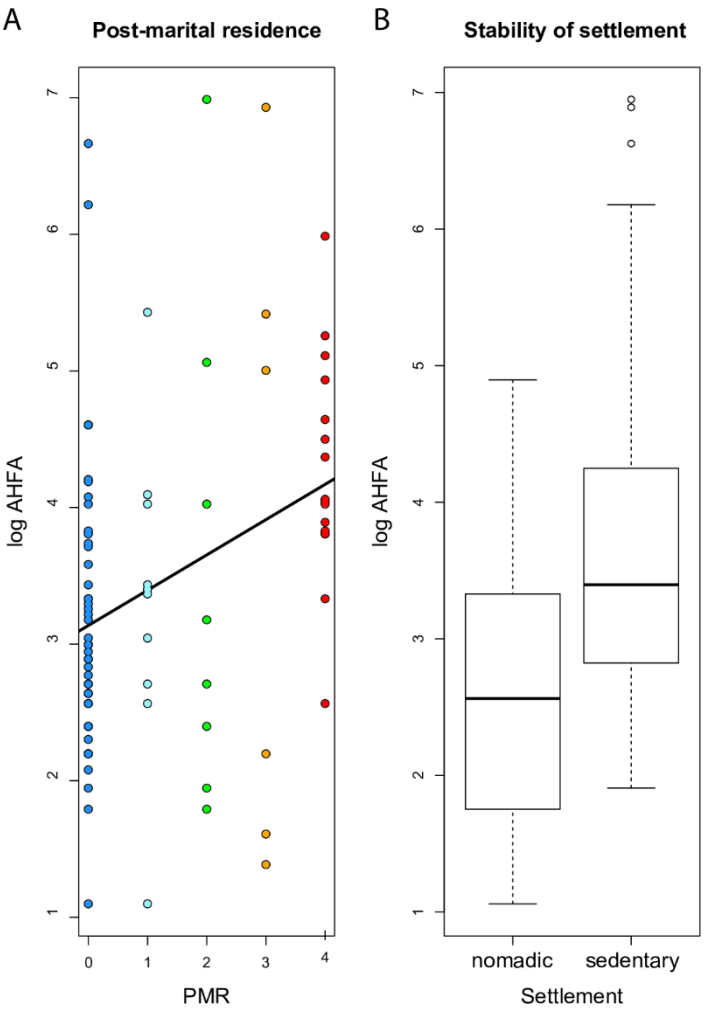

Fig. 1*. The association between (A) AHFA and PMR and (B) AHFA and settlement. Colors indicate tendency towards matrilocality (blue [0] = patrilocal, red [4] = matrilocal).*

Further research is needed to evaluate the effect of other factors on house size, such as differences in household wealth, sociopolitical organization, functional differences in dwelling use, or western influence. Future research could also focus on distinction between residence in the husband's or the wife's parents' dwelling (patrilocal and matrilocal) and residence within the husband's or the wife's community (virilocal and uxorilocal). Comparing the dwelling size with other measures of residence, such as Helm's measure (i.e. the relative number of co-

residing primary kin living with men versus women; Helm 1965), could provide additional insight.

Our results suggest that average house floor area can be used as a material proxy for inferring post-marital residence patterns in prehistoric societies. That said, we agree with previous suggestions that the correlations found "should only be used as working hypotheses to be tested with other lines of data" (Porčić 2010: 420). Such data can be acquired using bioarchaeological methods (e.g. strontium and oxygen isotope or ancient DNA analyses). Still, as shown in Case Study 1, isotopic evidence must be interpreted with caution. Isotope analyses can distinguish mobility between different geological regions, but not within one community or between communities living in regions with similar isotopic signal. Interpreting isotope results in the terms of post-marital mobility is not always straightforward, since other types of mobility could lead to the same signal (Furholt 2017). The evidence from cross-cultural and bioarchaeological analyses can complement each other, providing a more elaborated interpretation of the past social reality (cf. Case Study 3).

CASE STUDY 3. Post-marital residence patterns in LBK: Comparison of different models

Many ideas about post-marital residence rules in the society of the first farmers in the European temperate zone (Linear Pottery Culture, ca. 5500–4900 cal BC) has been proposed. While the relatively large average house floor area of LBK houses (c. 120 m^2) indicate matrilocal social organization (cf. Case Study 2), strontium isotope data (Bentley et al. 2012; Bickle and Whittle 2013) indicate patrilocality and community exogamy.

In this case study, we present several anthropological models, based on a review of ethnographic literature, and compare them with published strontium isotope results from two LBK cemeteries – Vedrovice (Czechia) and Nitra (Slovakia). We try to point out that 1) patrilocality and matrilocality are two opposite ends of a wide range consisting of many intermediate stages, rather than two distinct categories; and 2) there are other types of PMR, including neolocality (the couple establish a new household separate from their respective families), avunculocality (the couple live in the household of the husband's uncle), or shifting residence (people frequently move from one house group to another without any strict rules), which should be also considered.

Our results suggest that the most likely model of PMR in Vedrovice and Nitra is predominant patrilocality with predominantly exogamous communities. Most men (ca. 90-95%) seem to be local, while at least 30-45% of women are non-local. It can be expected that

other non-local men and women were not identified by strontium analysis, as they could have come from regions with a similar bioavailable strontium signal but different communities. In Vedrovice, possible movements due to PMR are indicated by the minimum age of 8-14 years of several non-local women. Also, higher age of non-local women (average 35 in Vedrovice, 39 in Nitra) than local women (31 in Vedrovice, 34 in Nitra), albeit not statistically significant, suggests that the former were already married. Differences in the proportion of non-local women between the two sites can be explained, for example, by different geology or by a different ratio of patri- / matrilocal or endo- / exogamous marriages.

However, other types of post-marital residence rules such as ambilocality, avunculocality or shifting residence cannot be ruled out, either, especially when we consider that polygyny or abduction of women could exist or that individuals buried at cemeteries might not be a representative sample of past LBK population. We also draw attention to the facts that post-marital residence patterns are often complex, geographical and social space not necessarily overlapping and exogamous rules difficult to detect with strontium data. Therefore, a hypothetical model combining patrilocality and matrilocality on different social and geographical levels is also proposed (Fig. 4).

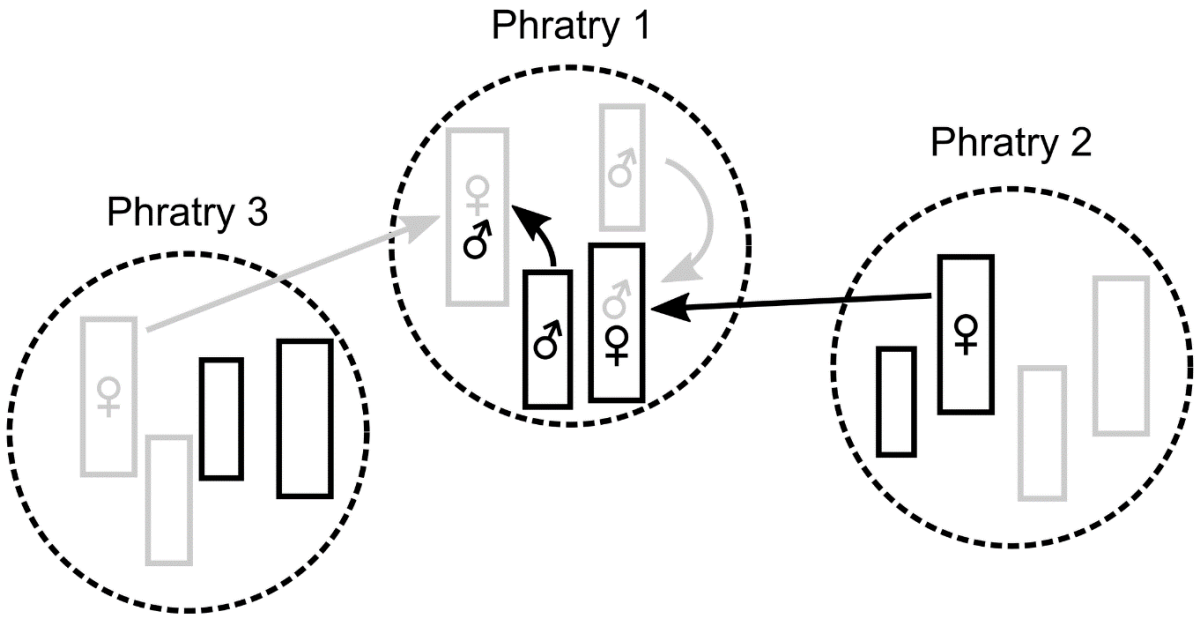

***Fig. 4**. PMR model combining patrilocality on the village (phratry) level and matrilocality on the longhouse (clan) level. Three phratries (villages) are ruled by the principle of exogamy and patrilocality. Two clans (grey and black longhouses) are ruled by the principle of exogamy and matrilocality.*

Summary

Due to the development of natural science methods, the focus of scholars studying past human mobility has shifted from cultural remains to human remains. In the future, we will thus certainly see many more research projects incorporating biogeochemical and genetic approaches. Still, isotopic and ancient DNA evidence must be interpreted with caution. As shown in our case studies, the same strontium results can reflect different human behaviors; this is true of modern (MacEachern 2000) and ancient DNA (Burmeister 2016) alike. In addition to the further development of natural science methods themselves, the development of theoretical concepts such as *identity* (Graves-Brown et al. 2012; Květina 2010) or *archaeological culture* (Eisenmann et al. 2018; Riede et al. 2019; Roberts and Vander Linden 2011), the study of multiple levels of human mobility together (e.g. Schachner 2012) as well as closer cooperation between the natural sciences and the humanities will be necessary.

Cross-cultural comparisons of ethnographic data enable researchers to identify diversity and commonalities in human societies. The knowledge of the range of human behavior enables archaeologists to better interpret archaeological evidence, while identification of common patterns can provide material correlates of past human behavior (Peregrine 2001, 2004). The combination of synchronic and diachronic comparative approaches (i.e. analyzing cross-cultural historical data) then allows to investigate dynamic processes generating cultural change (e.g. Seshat: Global History Databank project; Hoyer and Reddish 2019; Turchin et al. 2015). Nevertheless, developing a standardized methodology for incorporating cross-cultural approaches into archaeological research remains the greatest challenge for the future.

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2017:	Archeologie & Antropologie III (Prague, Czechia, 23 December)
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