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From Evenk campfires to prehistoric hearths: charcoal analysis as a tool for identifying the use of rotten wood as fuel

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ABSTRACT

We present a new approach combining ethnoarchaeology and experimentation aiming towards a better understanding of prehistoric firewood use and management. The example of present fuel management practices among a residentially mobile group of Evenk Siberian reindeer herders, shows how ethnoarchaeology can provide an analytical background for the study of complex man–environment interrelations. Ethnographic observation confirmed in particular that the moisture content and structural soundness of the wood can be linked to hearth function: rotten conifers for instance, are used for hide smoking by several groups living in the boreal forests of the Northern hemisphere. Charcoal samples from an Evenk hearth fed with rotten *Larix cajanderi* (Siberian larch) showed a high proportion of microscopic features diagnostic of fungal alterations.

A series of systematic experimental combustions on *Pinus sylvestris* (scots Pine) confirmed the existence of a relationship between the frequency and the intensity of fungal alterations visible after the combustion and the initial state of the wood used in the hearth. The establishment of an alteration index allows now to take a new parameter, the structural soundness of the wood, into account when performing archaeological charcoal analyses.

1. Introduction

Over the past years, charcoal analysis or anthracology has been used in combination with complementary approaches combining palaeoenvironmental and socio-economical studies that seek to discuss firewood management (i.e., the process of exploitation and use of ligneous fuel resources in a given environment) among prehistoric societies (Théry-Parisot, 2001; Asouti and Austin, 2005). In this regard, ethnobotany has emerged as a methodological approach (Chabal, 1994; Ntinou et al., 1999; Ntinou, 2002; Moutarde, 2007). Ethnoarchaeology benefits charcoal studies by revealing the complexity and the variety of firewood management practices, which are deeply embedded within the cultural and ecological context they originate from Henry et al., (2009). The analysis of this variability of practices reveals general patterns that can help fuel management theory building. For instance, ethnographic work carried out under very different latitudes reminds us that the criteria according to which a society chooses its firewood cannot be reduced to a "simple" taxonomic selection: other characteristics, such as the calibre or the state of the wood (i.e., green, seasoned, rotten), are at least as important as the species (Théry-Parisot, 2001; Zapata Peña et al., 2003; Alix and Brewster, 2004; Dufraisse et al., 2007; Henry et al., 2009; Joly et al., 2009; Picornell et al., 2011).

The behaviour of wood during combustion is measured in terms of heat efficiency (e.g. flame height, ember production, combustion speed, ignition qualities) and calorific value (total quantity of energy released by weight unit of fuel). As they are defined by the chemical and physical characteristics of wood, these properties are species-dependent; however, they are significantly modified by the calibre and the state of the wood (moisture content, structural soundness) employed, which have a greater influence on the combustion process than the species itself (Théry-Parisot, 1998, 2001).

One of the goals of experimenting in anthracology is precisely to identify these parameters in order to characterize the combustion more accurately and, therefore, to clarify the criteria for past firewood selection and use (Théry-Parisot, 2001; Ludemann and Nelle, 2002; Moskal-del Hoyo et al., 2010; Théry-Parisot and Henry, 2012).

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Generally, the methodology employed is the standardized production under controlled conditions of charcoal reference sets, on which morphometric analyses are performed in order to verify the existence of given causal relationships between the characteristics of the wood *ante* combustion (moisture content, structural soundness) and the presence *post* combustion of certain specific characteristics e.g., radial cracks, cell wall deformations, collapsed cells, fungal hyphae (Théry-Parisot, 2001; Badal and Carrión, 2004; Allué et al., 2009; Théry-Parisot and Henry, 2012).

A few experimental studies dealing with fuel use have also included ethnographic reference sets consisting mainly of samples from hearths and/or fuels (Mallol et al., 2007; Tsartsidou et al., 2008; Lancelotti and Madella, 2012; Gur-Arieh et al., 2013), but they remain rare in the field of charcoal analysis (Ntinou, 2002; Henry, 2011).

Through an approach combining ethnoarchaeology and experimentation, this paper focuses on the selection of rotten conifers for the fire. First, we analyse the place of this practice in the firewood management system of nomad Evenks living today in the boreal forests of south-eastern Siberia. Then, we present the results of the charcoal study of two Evenk hearths, which showed significant differences in the frequency and the intensity of microscopic wood decay features attributable to fungi. Supplementary laboratory experiments involved the analysis of 1250 charcoal fragments from 10 batches of *Pinus sylvestris* in different states in order to verify that the soundness of the wood can be inferred through charcoal analysis. Our results lead us to propose a method based on the micromorphological characteristics of wood decay for assessing the soundness of the wood ante combustion (healthy vs. dead vs. rotten) and its implications for prehistoric charcoal analysis.

2. Firewood management practices among Evenki of Amur Region

2.1. Context of the study

One of the aims of the ethnoarchaeological fieldwork (project "Système Renne") was to obtain first-hand information from human groups living under cold environmental conditions similar to those prevailing in Europe during the Upper Palaeolithic and/or the Early Mesolithic, in order to evaluate the impact of mobility and strong seasonal constraints on fuel management.

Nearly three months were spent in the North-eastern part of the Amur Region (Eastern Siberia, Russian Federation), with Oročon-Evenks associated with the village of Ivanovskoe (Evenk name Ulgen). Most of the time was spent in the taiga, on the territory of a group of reindeer herders, in the valley of the Kharga River and its slopes (Fig. 1). This area, at an altitude of 700–900 m a.s.l., is covered by boreal forest in which larch (*Larix cajanderi* Mayr.) is the dominant species.

In order to observe as many fire-related activities as possible, two fieldtrips were taken at different times of the year (late winter/beginning of spring 2006 and end of summer/beginning of autumn 2007). Direct field observations were complemented by a series of oral history interviews about traditional activities, beliefs and wood uses (Henry et al., 2009; Henry, 2011).

2.2. Firewood management: main results

Four main vegetation types were present within 2 km around the Evenk campsites we visited: riverine vegetation (Evenk:

Fig. 1. Location of the ethnoarchaeological survey.