Interpretation of firewood management as a socio-ecological indicator

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Summary: *We present and discuss the contribution of conceptual and ethnobotanical approaches for understanding firewood management in pre-industrial societies based on biotic ecology (hunting-fishing-gathering, pastoralism, agriculture). The elaboration of a "chaine opératoire" whose final product is fire and that is based on a common knowledge allows us to highlight complex ecological and cultural processes linked to firewood management. However, ethnobotanical methodology and models are rarely directly applicable to charcoal analysis. It is suggested that dendrometical tools and ethnoarchaeological data must be developed to improve our understanding of firewood management as a socio-ecological indicator.*

Key words: *charcoal analysis, fuel, firewood, dendrometry, ethnoarcheobotany*

INTRODUCTION

Humans belong to a complex adaptive system, whereby societies integrate with their environment through systems of production, exchanges, and transformations. These interactions and adaptations can be at least partially understood through the study of plant resources, which form the basis of subsistence and combustion fuel for human economies. The transition from a system of hunter-gatherers to one of pastoral-farmer-producers 8000 years ago in Western Europe accelerated these processes of "reciprocal influences". Archaeobotany therefore, is a discipline situated at the heart of these questions, and which allows us to understand the forms of co-evolution between humans and the management of plant resources over the *longue durée* (Thiébault, 2010).

The production of fire for heating, defense, light, cooking, and the production of goods is a technological act and constitutes in itself a socio-economic activity, dependant on the social context (Dufraisse *et al*., 2007). It is important to consider whether anthracology represents an adequate approach to comprehend this technological act with its socio-economic dimensions, and how the study of carbonized wood remains can document the forms of co-evolution between humans and the botanical environment.

SOCIO-ECONOMIC ASPECTS OF FIREWOOD SELECTION

To respond to these questions we have adopted the analytic approach of technologists in order to deconstruct a "total fact" (here, the production of fire) and to propose an adapted analytic grid. This permits the systematic collection of data that can be used to inform the anthracologist. Thus, Figure 1 is constructed using a common knowledge base that relies on historical, ethnographic, universal principles and archaeological data.

However, this *chaine opératoire* brings to light a number of intrinsic and extrinsic characteristics for which the mechanisms of adaptation and feedback are still poorly understood. The development of (i) dendrometric tools to highlight the intrinsic characteristics of the wood resources collected and the forested plant communities that were exploited and (ii) ethnoarchaeobotanical references to understand their socio-economic functions, appear crucial for the analysis of firewood management as a socio-ecological indicator.

The *chaine opératoire* proposed here shows that while the environmental constraints may be numerous, technological and economic choices significantly influence the patterns of firewood selection at many stages. For example, we cite wood diameter. Recent years have seen the development of techniques to measure the radius of curvature and of models to reconstruct the diameters of the wood exploited using wood charcoal remains. Their application to the Neolithic sites around Chalain Lake (dated between 3200 and 2700 BC) has demonstrated that the wood selected, less than 10 cm in diameter, reflects very specific technological demands, related to accommodating a hearth in a wooden construction. As a result, when the human communities occupying the shores of the lake were forced to harvest the largest trees, as a result of the exploitation of new territory, we note an increase in the frequency of splitting mauls in the archaeological strata.

However, not all of the stages of the *chaine opératoire* necessarily lead back to the same social, technological, and economic processes. A number of concepts or theories such as time allocation, optimal foraging, or carrying capacity return specifically to the socio-economic organization of these communities and permit the anthracologist to propose better developed socio-ecological interpretations. We mention the comparative example of sites in Central Belgium and French Jura, where at different points during the

Neolithic, agricultural practices (intensive cultivation of small areas in Belgium vs. extensive cultivation of larger areas in Jura) seem to have determined the management strategies of firewood, and therefore also the paleoecological representativeness of the anthracological assemblages (Salavert and Dufraisse, in preparation). Here, again, the development of dendrometric tools focused on the width of growth rings, should permit us to more precisely narrow down our estimates of the distances traveled, a parameter that seems essential.

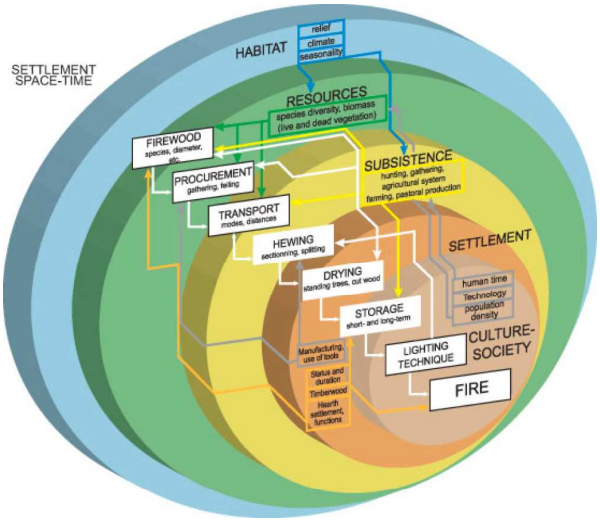

FIGURE 1. Intrinsic and extrinsic characteristics of the chaine opératoire related to the production of fire.

THE CONTRIBUTION OF ETHNOBOTANY

Ethnobotanical methods offer considerable promise for improving our understanding of the different forms of selection and use of wood. Supported by concepts of species diversity and the calculation of indices (Gentry and Philipps, 1993), these methods provide a deeper understanding of the use of different wood fuels and their availability in the local environment. Transposed to anthracology, it was possible to demonstrate that during the Middle Neolithic of Clairvaux Lake (4000-3600 BC) the wood species that occurred most abundantly in the environment were not necessarily those used for fuel (Dufraisse *et al.,* in press).

The models that result from ethnobotany often bring up ideas that we have not yet mastered and that cannot be directly applied to anthracology. We cite the model of the law of least effort proposed by Shackleton and Prins (1992), whose fundamental principles depend on the abundance of wood in the past (which the anthracologist cannot know) and on the population density (which is a debated parameter in archaeology).

On the other hand, ethnoarchaeology's objective is to seek out interpretative keys that are applicable beyond the narrow framework of a single period, region, or culture (Gallay, 1986). The development of this goal, applied to the management of plant resources, what can be termed *ethnoarchaeobotany*, begins to enrich our frames of reference (for example Piqué, 1999; Picornell, 2009) and should permit us to understand and interpret the functions and mechanisms that underlie the *chaine opératoire.*

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