MAISON DE LA RECHERCHE
Proceedings of the Round table, November 22-23 2012, Toulouse (France)

2014 # 6

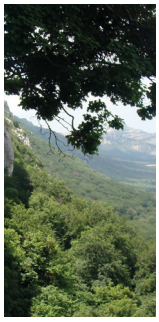
http://www.palethnologie.org
ISSN 2108-6532

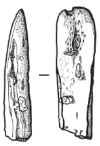
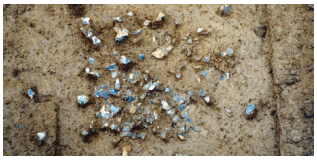
directed by

Auréade HENRY
Benjamin MARQUEBIELLE
Lorène CHESNAUX
Sylvène MICHEL

TECHNIQUES AND TERRITORIES

New Insights into Mesolithic Cultures




P@LETHNOLOGY
Bilingual review of prehistory

P@LETHNOLOGY
Bilingual review of prehistory

Review published by the P@lethnologie association, created and supported by the TRACES laboratory, Inrap and the Ministry of Culture and Communication.

Contributions should be addressed to:

REVUE P@LETHNOLOGIE
Vanessa LEA, Research associates

TRACES - UMR 5608 of the CNRS
Maison de la recherche
5 allées Antonio Machado
31058 Toulouse cedex 9, FRANCE

Phone: +33 (0)5 61 50 36 98
Fax: +33 (0)5 61 50 49 59
Email: vanessa.lea@univ-tlse2.fr

This digital publication received support from

Université Toulouse Jean Jaurès
Liberté • Égalité • Fraternité République Française
Ministère Culture Communication
cnrs dépasser les frontières
Inrap Institut national de recherches archéologiques préventives
TRACES
Université Nice Sophia Antipolis

FUEL USE AND MANAGEMENT DURING THE MESOLITHIC:

Recent Approaches in Archaeobotany

Auréade HENRY, Isabelle THÉRY-PARISOT

To cite this article

Henry A., Théry-Parisot I., 2014 - Fuel Use and Management during the Mesolithic: Recent Approaches in Archaeobotany, in Henry A., Marquebielle B., Chesnaux L., Michel S. (eds.), *Techniques and Territories: New Insights into Mesolithic Cultures*, Proceedings of the Round table, November 22-23 2012, Maison de la recherche, Toulouse (France), *P@lethnology*, 6, 65-83.

FUEL USE AND MANAGEMENT DURING THE MESOLITHIC:

Recent Approaches in Archaeobotany

Auréade HENRY, Isabelle THÉRY-PARISOT

Abstract

In order to propose working models for the Mesolithic period, this paper presents recent developments in archaeobotany orientated towards the question of fuel management systems and how ethnographic studies and experimentation can enhance our understanding of past phenomena.

The importance of fire and its systematic use during the Mesolithic can be assessed through direct evidence, i.e. the recovery of burned materials with wood, stone, bone and plant remains being the most commonly encountered. The diversity of activities related to fire is also suggested by indirect testimonies, such as the presence of materials (or their processing traces on artefacts) for the production of which a thermic treatment is needed, such as birch tar, animal hides, etc. In accordance with these observations, fuel management practices of Mesolithic societies were undoubtedly complex and culturally significant. However, they remain difficult to approach archaeologically: What kind of fuel was collected and for which purposes? What is the relationship between environment, fuel selection, hearth and site functions?

Keywords

Mesolithic hearths, fuel use, charcoal analysis, phytoliths, experimentation, ethnoarchaeology.

Introduction

It is now widely recognized that the wood charcoal found in archaeological sites reflects accurately the vegetation present in the firewood procurement area (Chabal, 1982, 1991, 1997; Chabal *et al.*, 1999; Asouti, Austin, 2005). However, because the function linking the anthracological spectrum with its source-vegetation is unknown, anthracologists have begun to address the successive filters built up between the ligneous vegetation and the anthracological diagram (Théry-Parisot *et al.*, 2010a-b). Studies integrating not only the firewood management strategies of past societies, but also the effects of combustion and depositional or post-depositional processes on wood charcoal allow us to evaluate the diachronic transformations of the material "wood" and then the charcoal assemblages, and to thus refine our perception of the ligneous environment and its exploitation by humans. These "classic" anthracological questions are now joined by studies aimed at identifying other fuels and their properties (Théry-Parisot, 2001; Théry-Parisot, Costamagno 2005; Delhon *et al.*, 2008; Braadbart *et al.*, 2012). Therefore, the study of fuel management in reality consists of an integrated approach that involves several tools (morphometry, experimentation, modelling) and / or research disciplines (ethnography, zooarchaeology, phytolith analysis, physic-chemical analyses, etc.; figure 1).

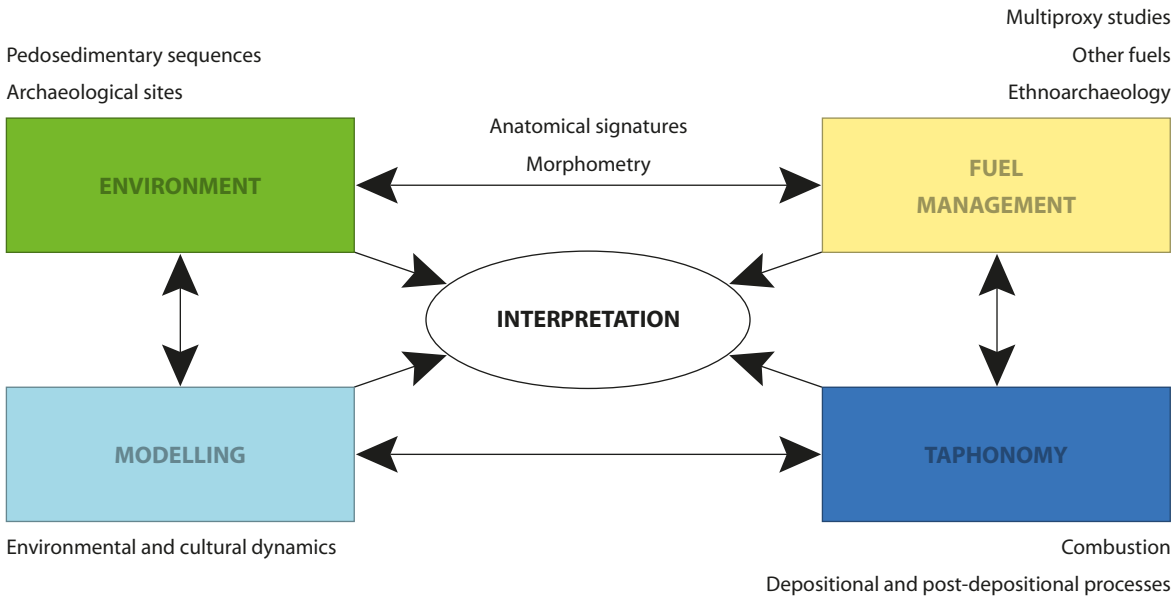


Figure 1 - Research domain : fuel management.

In the framework of a doctoral thesis on the Mesolithic of south-western France, we addressed the relationships between the environment and fuel management, while beginning to explore the manners in which social practices can be brought to light through charcoal studies (Henry, 2011). A brief evaluation of research progress for the period in question shows that paleoenvironmental studies are relatively numerous, but unevenly distributed across France (taphonomic conditions, research context, etc.), while data on the use of fuels are rare and scattered. To cite just one example, the range of fuels potentially used by Mesolithic groups has not been studied in-depth: due to the increased biomass since the end of the Pleistocene and the good preservation of wood charcoal in numerous archaeological sites, researchers have rarely inquired into the use of other fuel sources during this period. Meanwhile, understanding the choice of a fuel in terms of available vs. used resources used is crucial to obtaining a better knowledge of the social, as well as paleoenvironmental, context of a human group.

From this perspective, a priority in our work has been to construct a theoretical and methodological framework for the study of fuel management (Henry, 2011). In other words, "*an approach to phenomena that are unique in particular, but similar in general*" (Bentley, 2003: 9) enabling a consideration of both the cultural and environmental diversity encountered throughout the period, and the particular features associated with each archaeological site. This systemic approach follows the current orientations in research on fuels, with the interpretation of archaeological data being largely based on the creation of experimental and ethnoarchaeological reference datasets.

1 - Theoretical framework: a systemic approach

To develop a methodology adapted to our research subject, a fundamental step is to identify the parameters that operate in (and have an influence on) the processes involved in producing and using fire, starting from the environment from which the fuel was collected until the fire is abandoned (Théry-Parisot, 2001). In doing this, we quickly realize that "simple" behaviors or actions, such as wood collecting, are part of a system of complex relations (figure 2).

The framework of our research is thus situated at the interface between the socio-ecological context (Mesolithic groups interacting with their environment) and the fuel resources used, and resulting from, these interactions. The environmental conditions (climate, topography, pedological and geological facies, vegetation, etc.) probably always had a determining influence on fuel management strategies. The environment evidently imposes limitations, but does not alone determine the modalities or frequencies of its exploitation (Friedman, 1974; Ingold, 1980). This is probably also true in the domain of ideology, which likely defines a framework for the exploitation of fuel resources, but does not determine it alone.

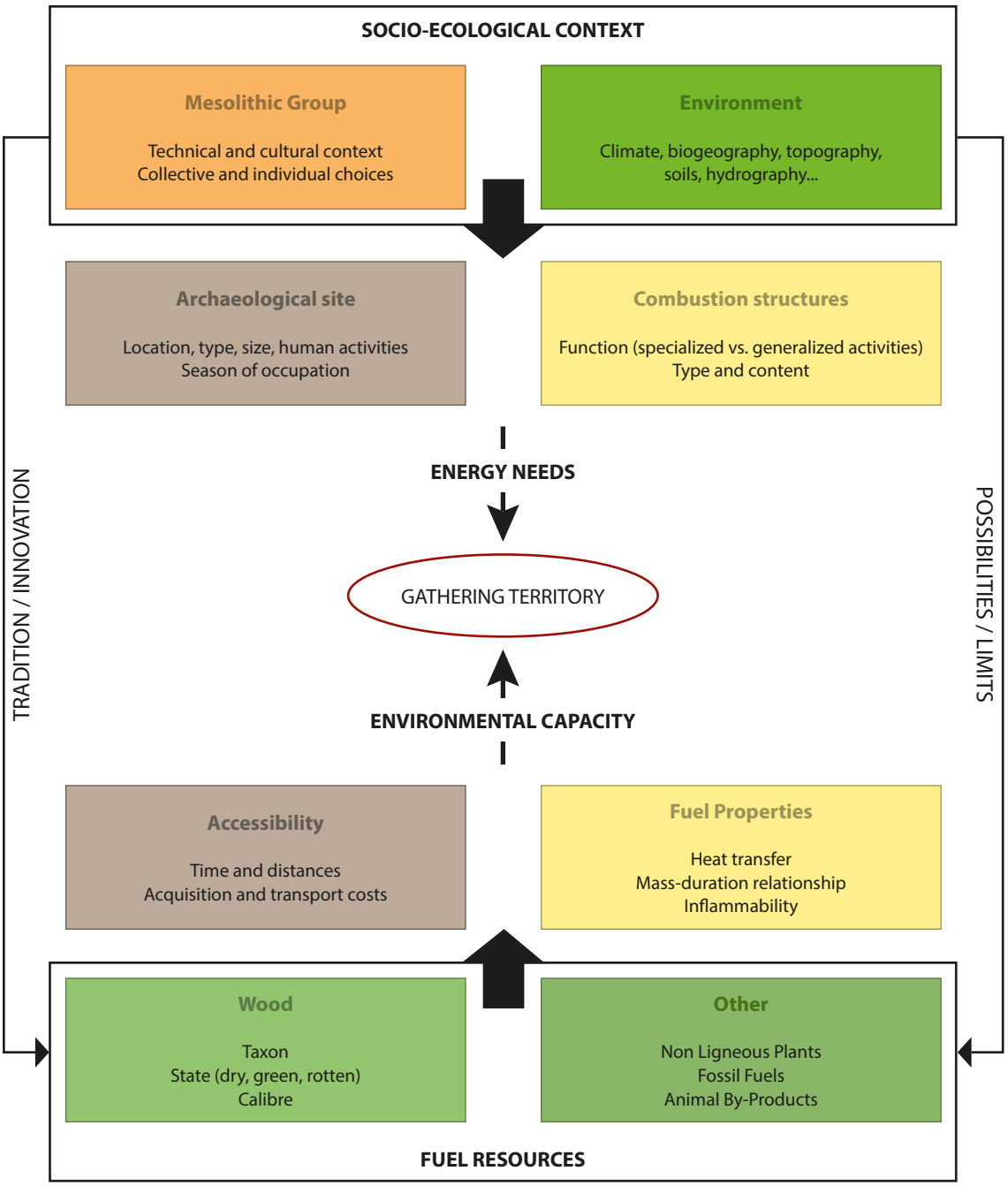


Figure 2 - Fuel management system (after Théry-Parisot, 2001, Henry *et al.*, 2009, modified).

The parameters related to the organization of groups, such as their size and by extension the size of sites, as well as their function and their occupation duration, influence the nature and intensity of activities linked to fire (Théry-Parisot, 2001). These latter have an impact on the consumption of fuels. The satisfaction of the fuel needs of groups (in terms of modalities or capacities) is an expression of the socio-ecological context: the social organization (division of labor, procurement frequency), collection techniques (collection tools, knowledge of the location and properties of different fuels), and ideological factors (perception of the environment, habits, interdictions / preferences, etc.) intervene at all stages of fuel collection and use. The satisfaction of energy (fuel) needs occurs within a given time frame, but also space; it is thus linked to both the occupation duration and the environmental and / or seasonal conditions that influence the nature of the needs, while also determining the productivity of the environment, meaning the exploitable biomass over a given surface area, which in turn contributes to the delimitation of the territory covered by the group for procurement. To summarize, fuel management represents "*the expression of the relationship between the energy needs of groups and their capacity to satisfy them*" (Théry-Parisot, 2001: 148).

Of course, these relationships and their nature are not all unilateral and participate in continuous and multidirectional exchanges between the different parameters if only the scale and / or observation angle is modified. Therefore, in the more or less long term, the use of wood does or does not have an influence on the environment, the productivity of the location, the methods of exploitation, or all of the parameters together. Variations in consumption can also influence the social organization (and vice-versa), or the productivity of a location, which in turn can also influence consumption, etc.

The nature of certain parameters indicates that it is impossible to determine, in archaeological terms, all of the complexity of different situations. Nonetheless, just taking this into account enables us to develop a better-adapted approach, forcibly involving the integration of results from other paleoenvironmental disciplines, along with archaeological data (Théry-Parisot, 2001; Hather, Mason, 2002). As a result, cultural facies, occupation types, procurement territories, site functions, all of which provide direct or indirect evidence of activities linked to fire (burned materials, tools, activities requiring the use of fire, etc.), are all factors that must be considered when attempting to understand the particular nature of firewood management by past human groups.

2 - Which fuels for which uses?

The fuel residues found in archaeological sites provide direct evidence of the importance of fire to the economy of societies. The persistence of the fireplace as a central element in the activities of human groups since at least the beginning of the Upper Paleolithic enables us approach Mesolithic groups from a paleo-ethnographic perspective (Gallay, 1999). The archaeological data suggest that fire intervened in a broad range of activities, which nonetheless remain difficult to identify, and it is generally believed that prehistoric fires had several had several simultaneous and/or successive functions (Perlès, 1977; Taborin, 1989). These functions can be divided into two broad groups of activities: (i) activities that we designate here as "domestic", which are associated with the daily production of fire for drying, lighting, heating, protection, food preparation, the elimination of waste, etc. Their non-specialized nature distinguishes them from activities in which fire plays a role in the operational sequences of processing and/or transforming materials. Within this latter category, the demonstrated or suspected uses of fire during the Mesolithic are highly varied.

A - A few uses of fire in the Mesolithic

Different thermic treatments (roasting, drying and smoking) can be used to preserve perishable foods for their deferred consumption at a different site and / or during a season different from that during which they were acquired (e.g. Zapata *et al.*, 2002). It is also likely that fire played a role in the tanning / smoking of certain hides, as has been observed nowadays in many traditional groups (Beyries, 2008). The fabrication of adhesives, such as birch tar, which residues are mainly found on stone artifacts such as arrowheads, requires a heating phase (Pollard, Heron, 1996; Regert, 2004). The thermic treatment of stones in the context of different activities (fracturing, ochre preparation) has been observed (Guilbert, 2001; Brochier, Livache, 2003; Rozoy, 1995; Marchand, this volume). The use of fire as a tool for shaping and hardening wood has also been observed (Mordant, Mordant, 1987). More hypothetically, it is also possible that during this period fire was used away from the habitat site in controlled burn practices associated with subsistence activities (Mason, 2000; Ryan, Blackford, 2010). Finally, though it is difficult to observe, it is plausible that fire played an important symbolic role in Mesolithic belief systems, as is indicated by the funerary practice of cremation (Schulting, 1998; Verjux, 2007).

The skillful use of fire in the context of diverse activities requires a complex management of fuels, especially since fire-related activities must have varied in time and space depending on the cultural and technical traditions of groups, as well as seasonal and / or circumstantial needs.

To summarize, the lifeways of a group have a determining influence on their manner of managing fuels. Therefore, a better understanding of fuel-related practices should contribute to our knowledge of Mesolithic lifeways. The following question is thus raised: to what extent can the study of fuel residues found in archaeological sites enable us to characterize social practices?

B - Fuel economy in the Mesolithic

a - Potential alternative fuels

To our knowledge, only two zooarchaeological studies have addressed the question of the use of bone and cervid antler as fuel (respectively Thibeau, 2008; Bridault *et al.*, 2009), even though bone use is widely known for the Paleolithic (Cain, 2005; Théry *et al.*, 2005; Costamagno *et al.*, 2009). Based on the negative results of these studies, it appears difficult to generalize or conclude that the use of bone as a fuel is specific to the Paleolithic.

In the same manner, we could hypothesize that the use of lignite, occasionally observed in the Paleolithic / Epipalaeolithic (Théry *et al.*, 1995), becomes obsolete in the Mesolithic. This material is not always easy to identify, however, and only two anthracological studies of Mesolithic sites have addressed this question (Théry *et al.*, 1996; Henry, 2011).

For the Mesolithic, there is no information on the possible use of peat or non-ligneous vegetal materials (herbaceous plants, leaves) as fuel. We believe that the development of a methodology adapted to the identification of these elements in archaeological contexts is one of the research priorities in this domain.

Finally, excrements, especially those of ruminants, may have been employed, given their use by many modern pastoralist societies for their specific combustible properties (Johannessen, Hastorf 1990; Zapata Peña, 2003). Starting in the Neolithic, the floors of sheepfolds, regularly cleaned by fire, provide evidence for livestock penning through the identification of fossil "manure" (Brochier, 1983, 1996; Delhon *et al.*, 2008). The ability to identify these materials archaeologically (Gur-Arieh *et al.*, 2014) raises the question of their use as fuel during Mesolithic, but also Neolithic times, not yet demonstrated.

b - Firewood

An archeo-anthracological deposit is a reflection of both the original ligneous vegetation and its use as a fuel. However, though an anthracological study conducted under good conditions provides a coherent image of the locally available ligneous vegetation, without complementary data (palynology, carpology, other paleoenvironmental data), it does not permit a full evaluation of the criteria for selecting ligneous fuel materials. Given the good paleoecological representativeness of charcoal remains, should we consider Mesolithic behaviors as opportunistic (e.g., Piqué, 1999)? In other words, an absence of selection in the procurement of firewood would give only a slightly biased image of the ligneous vegetation in the procurement zone. It would also imply that one of the main factors determining fuel management systems in the Mesolithic would be a limited collection effort (Delhon, Thiébault, 2009). This hypothesis nonetheless remains to be validated, since we know almost nothing about the firewood collection strategies: were they driven by a taxonomic choice or a set of criteria (Théry-Parisot, 1998, 2001, 2002)? Parameters such as the size and/or state of the wood modify not only the behavior of taxa when burned, but also their combustion properties. For example, combustion will always be more rapid with smaller pieces, regardless of the species, since the fireplace is more oxygenated. It can be slowed down if the wood is green or moist, and accelerated if it is decayed (e.g. the "flash" combustion of wood that has lost most of its combustible properties). The calorific value represents the total quantity of heat released per unit weight of fuel (Chabal, *op. cit.*). Being dependent on the chemical composition of the species, it is greater for taxa rich in extracts (resins, tannins) and lignins than for taxa with a higher cellulose or ash content. That being, the differences in the calorific value of different species are relatively small, while they increase considerably depending on the state of the wood (*ibid.*). Green wood, for example, has a very low calorific value. We thus understand how the "species" criterion can become secondary in the collection of firewood, without necessarily adopting a deterministic conception. To summarize, serious inquiry into the burning qualities of the species used and, by extension, the potential functions of fireplaces, is possible only with knowledge of the sizes and/or states of the wood before combustion (Théry-Parisot, 1998, 2001). Finally, the state of the wood (green, dead, rotten) and its size are also related to the strategies for procuring it (felling/collection, kindling, etc.). It is thus imperative to reach beyond the "classic" anthracological information to identify the state and/or size of the wood used in fireplaces, in order to reconstruct fuel selection strategies.

3 - What tools can we use to shed light on the practices of Mesolithic societies?

Research progress in this domain thus depends on the existence of solid modern reference bases, which are still under development. These latter are based on the acquisition of analogical data that can be compared and ultimately transposed to archaeological materials.

A - Observing modern fuel management systems

To test the hypothesis that human behaviors played a perceptible role in the nature and the composition of anthracological assemblages, ethnoarchaeology is a pertinent research tool (Ntinou *et al.*, 1999; Ntinou, 2002). It enables us to obtain a global understanding of each fuel management system since all of the interacting parameters are observable or even measurable (Henry *et al.*, 2009). For each recorded context, we can thus evaluate the influence of the human

filter on anthracological deposits *before* the intervention of post-depositional processes, which also bias our perception of past phenomena and must consequently be dissociated from human processes through other types of research (e.g. taphonomic analyses of wood charcoal by Théry-Parisot, 2001; Chrzavzez, 2013; Chrzavzez *et al.*, 2014).

The ethnoarchaeological approach must enable us to replace our research question into a well-known reference context, which the archaeologist, in any case draws upon in his/her interpretations, in the same way that the reproducibility of observations must be evaluated in conjunction with a search for explanatory mechanisms (Gardin, 1979; Gallay, 1980, 1986). This procedure permits us to expose the complexity of behaviors and situations in response to models that are sometimes too simplistic (Asouti, Austin, 2005).

Ethnoarchaeological observations obviously cannot be directly applied to archaeological contexts, but provide us with a basis for reflection through observations of the relationships between human practices and charcoal deposits in well-defined situations. The ultimate goal of such an approach is to feed our achaeological models with elements relating to both the paleoecological representativeness of wood charcoal and criteria for selecting fuel materials.

The ethno-anthracological research literature on fuel management has been greatly enriched over the last decade. It consists mainly of observations of sedentary / sedentarized societies (Johannessen, Hastorf 1990; Ntinou, 2002; Zapata-Peña *et al.*, 2003; Alix, Brewster, 2004; Moutarde, 2006; Dufraisse, 2007; Brandisauskas 2007; Joly *et al.*, 2009; Llorenc Picornell *et al.*, 2011; figure 3).

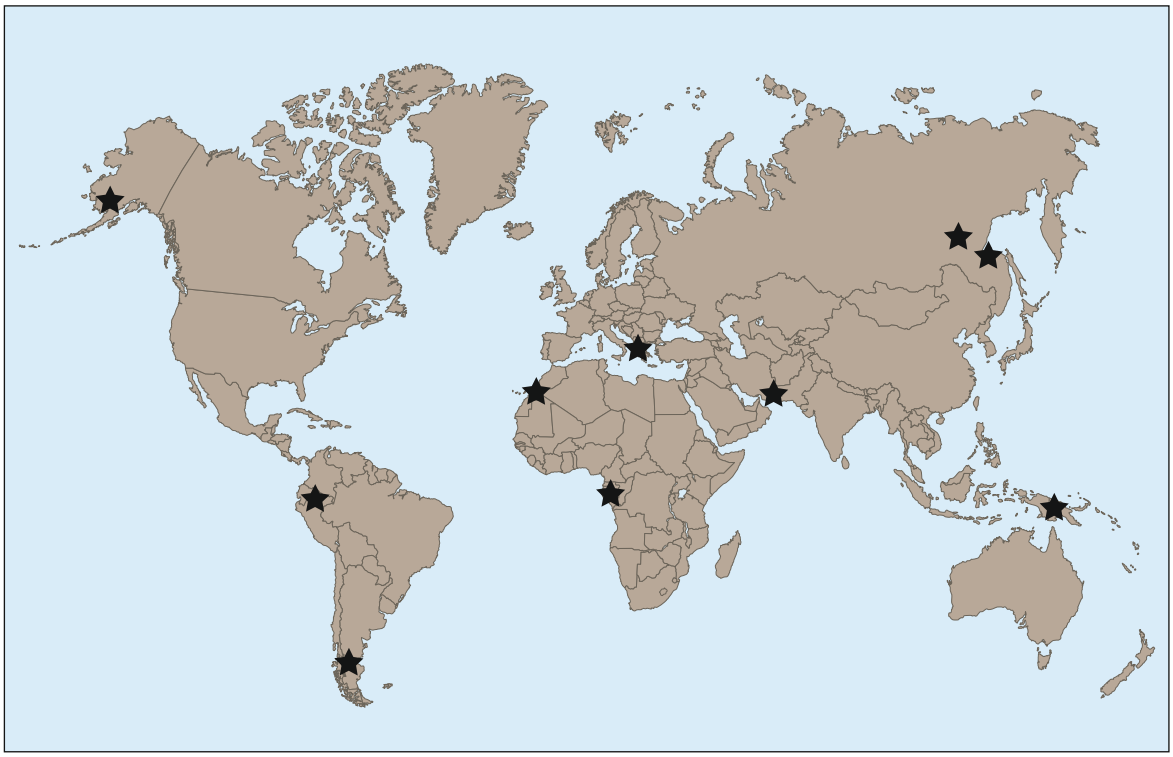


Figure 3 - Locations of the ethno-anthracological references cited in the text.

In the context of mobility and the strong influence of seasonality that is characteristic of Mesolithic societies, it was important to investigate the relationship between societies and the forest and the influence of these lifeways on fuel management strategies. Following this perspective, a first ethno archaeological study was realized in the taiga with the Evenks of the Amur region in eastern Siberia (Henry *et al.*, 2009; figure 4). Working with nomadic Evenk groups living in one of the southernmost boreal forests in the northern hemisphere provided the basis for very relevant reflections on life in a forest environment. While these reindeer herders in the taiga clearly practice an economy that is specialized and focused on animals (Ingold, 1980), it is traditionally much more diversified than that of their homologues in the extreme north of Siberia (*ibid.*). In addition, the biomass (as well as the taxa encountered) is similar to that which was available to the first Mesolithic groups living in European mountain areas and / or northern Europe. Ethnoarchaeological studies have moreover already been realized with Evenk groups in the context of research on the Mesolithic in northern Europe (Grøn, Kuznetsov, 2004).

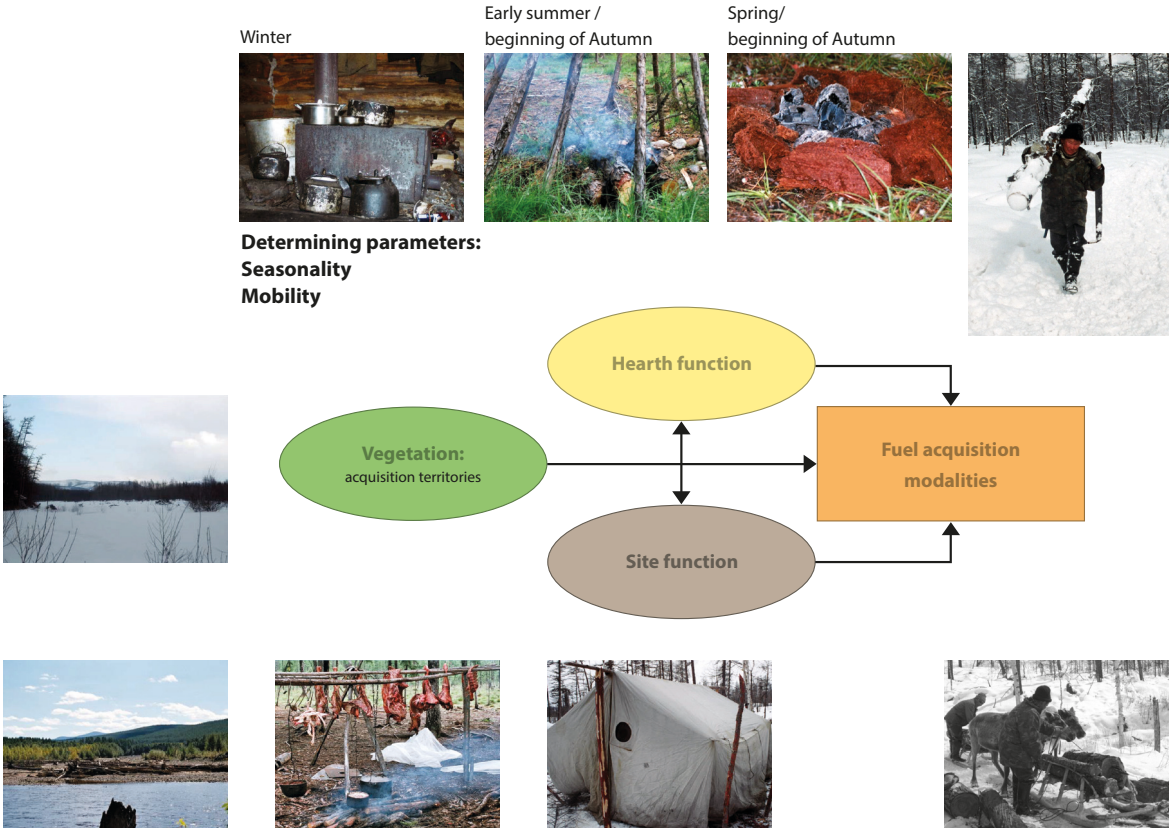


Figure 4 - Diagram of the management of firewood by an Evenk group in eastern Siberia (photos: A. Henry, ACI Système Renne).

Our results indicate that the study model for fuel management is well adapted to recording the practices of modern groups in all their complexity (Henry, 2011). Some observations arising from this boreal context can be retained as working archaeological hypotheses:

i. Specialized fireplaces have a strong cultural significance and their contents are often different from those of non-specialized fireplaces.
ii. The addition of non-ligneous vegetal materials is not forcibly due to a lack of wood; it corresponds to a specific function of the fireplaces and can be highly diagnostic of seasonality.

iii. The number and nature of activities linked to fire depend on the season; these activities participate in the definition of the function of the site.
iv. Fuel selection is an active process which does not forcibly contrast with the good ecological representativeness of the fuel residues; this is notably because:
v. The selection of the state of the wood (green / seasoned- healthy / degraded) is sufficient to satisfy all hearth functions. It is at least as important as the wood species.

The confirmation, through ethnography, of the importance of a group of features that define an appropriate fuel – size, physiological and phonological state of the wood, species, etc. – must induce archeobotanists to question the nature of the choices made *before* any attempt to interpret a fireplace based only on the wood species.

For this reason, to advance in the characterization of fuels, it is essential to constitute experimental reference datasets.

B - Constituting experimental reference bases

The constitution of reference bases that enable the identification of anatomical markers on wood charcoals, dedicated to the interpretation of practices (fuels used, collection strategies, selection of wood size and / or state) is a long-term process that requires the production of a large number of replicas under laboratory conditions. After this phase of validating the cause and effect relationships between a material in a given form or state and the appearance of specific *post* combustion features, a second important step in experimentation is to transpose these modern observations to archaeological contexts. Below is a brief inventory of a few studies in progress.

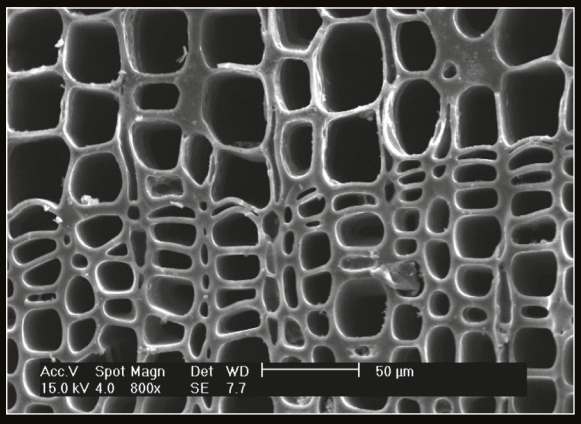
a - The soundness of the wood

It is possible to identify the soundness of the wood (i.e., healthy, dead, degraded) by identifying and quantifying the action of microscopic fungal decay features. This action results in alterations to the cellular structure of the wood that are sometimes visible on the anthracological remains (figure 5), serving as markers for the identification of dead or decayed wood (Théry-Parisot, 2001; Moskal-del Hoyo *et al.*, 2010). To interpret archeological chacoal remains in terms of the soundness of the wood used in fireplaces, a tool for the identification of healthy, dead and decayed conifer wood was developed (Henry, 2011). The anthracological study of an Evenk fireplace specialized for hide smoking and fed with decayed wood enabled the identification of a relationship between certain visible modifications of the microstructure of the charcoals and the combustion of degraded wood. A series of experiments with open fireplaces involving the observation of more than 1 500 conifer wood charcoals confirmed this observation and enabled the creation of an index of the sanitary state of the wood *ante* combustion, applicable to archaeological wood charcoals (Henry,Théry-Parisot, 2014). Other groups of taxa remain to be tested.

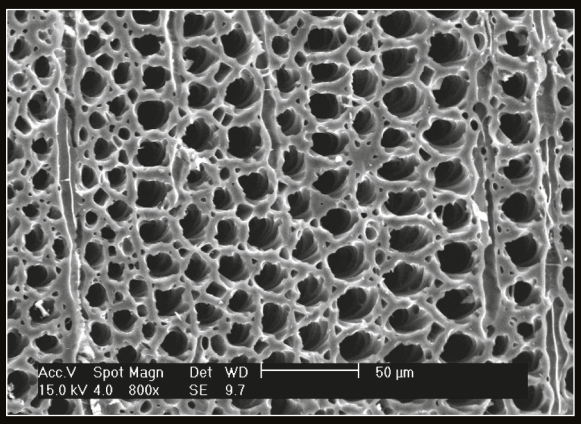
b - The moisture content of wood

Hypotheses concerning the identification of green wood (as opposed to seasoned wood) based on charcoal remains are based in part on the presence of radial cracks and vitrification (Marguerie, Hunot, 2007). The conditions for the appearance of the latter phenomenon are poorly understood. We can nonetheless eliminate the combustion of green wood (Henry, 2011) and high temperatures (Mc Parland *et al.*, 2010; Henry, 2011) as possibilities. Recent studies show that the potentially relevant variables are probably related to the state of decay of the wood used and/or charring in a reductive atmosphere (Henry, 2011).

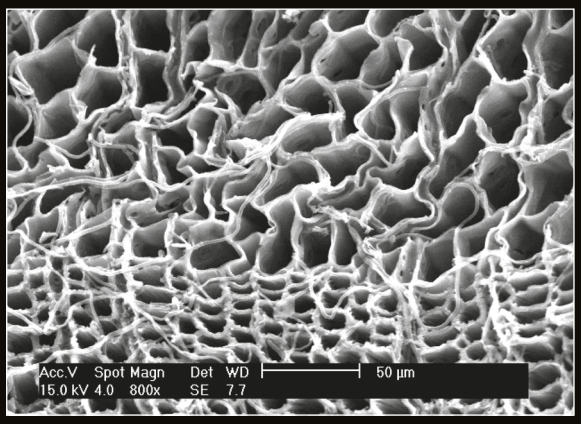
Transversal section, charcoals of coniferous wood:



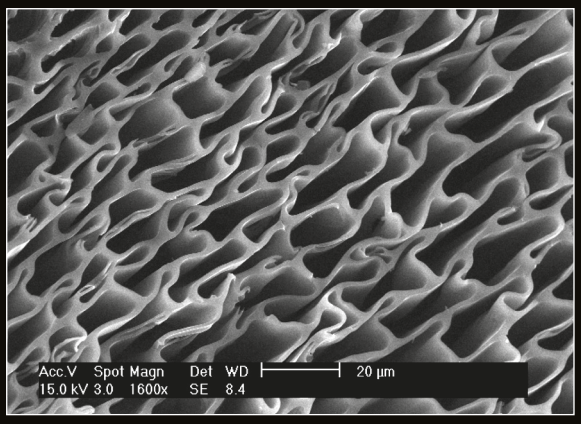
A - Showing no fungal degradations



B - At an incipient stage of degradation: formation of cavities in secundary walls



C - Progressive erosion of the cell walls, which appear fragile and porous

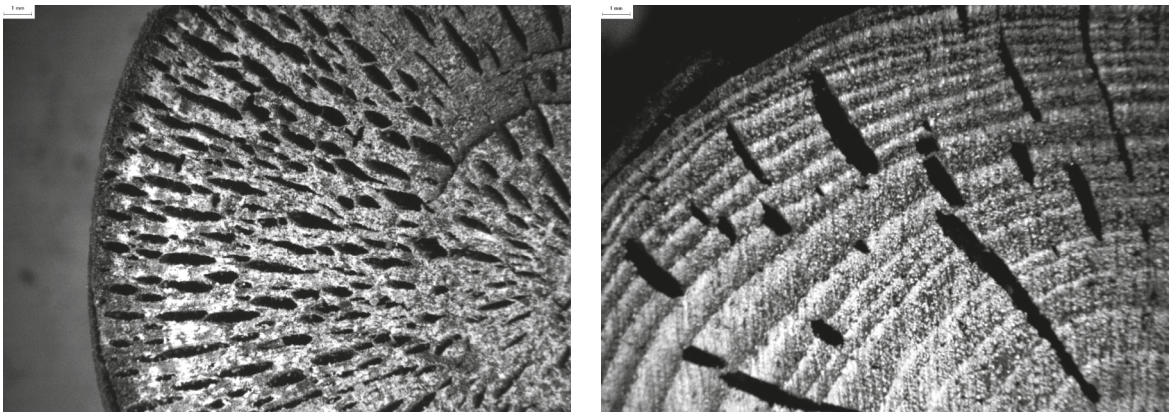


D - Degraded and collapsed cell walls

Figure 5 - Main features of the degradation of conifer wood by decay fungi (photos : M. Repoux, CEMEF, Sophia Antipolis).

The simple presence of radial cracks on wood charcoals does not necessarily indicate the use of green wood in a fireplace (Théry-Parisot, 2001). On the other hand, the combustion of green wood results in an increase in the number of cracks per mm²; these cracks are also morphologically shorter and wider than those observed on seasoned wood (Théry-Parisot, Henry, 2012; figure 6). These results have been confirmed by a similar experimental study with species from the Patagonian region in Argentina (Caruso Fermé, 2012). The modalities for transposing these observations to archaeological contexts nonetheless remain to be determined.

Transversal sections, experimentally produced charcoals:



A - Resulting from the combustion of green wood (*Pinus sylvestris*)

B - Resulting from the combustion of seasoned wood (*Pinus sylvestris*)

Figure 6 - Morphology of radial cracks on experimental samples charred under laboratory conditions – muffle furnace (photos: I. Théry-Parisot).

c - Wood diameter

The description of wood sizes (diameters) in anthracological remains is a relatively ancient approach (Marguerie, 1992), still recently applied to the Mesolithic site of Pont-Glas (Marcoux, 2009). Measuring methods have since been improved (Chrzavzez, 2006; Paradis-Grenouillet *et al.*, 2010). Research on the potentials and limitations of this analysis tool have also advanced significantly (Chrzavzez *et al.*, 2011; Théry-Parisot *et al.*, 2011; García, Dufraisse, 2012), in the framework of the "Dendrac" ANR project (dir. by A. Dufraisse), for example, whose results will soon be published.

d - Other fuels

Finally, growing numbers of experimental analyses of other combustible materials, many involving the constitution of reference datasets, enable investigations into the motivations for their use; these materials include lignite (Théry-Parisot, 2001; Henry, 2011) and bone (Théry-Parisot, *ibid.*; Théry-Parisot, Costamagno, 2005; Mentzer, 2009). Physico-chemical and phytolithic analyses with the objective of identifying the use of dung and/or manure are also being conducted (Delhon *et al.*, 2008; Braadabart *et al.*, 2012; Shahack-Gross, 2011; Lancelotti, Madella, 2012; Gur-Arieh *et al.*, 2014).

Conclusion

Anthracology currently provides answers to a certain number of questions, but only a true interdisciplinary approach can enable the development of fuel management models for the Mesolithic that are open to other technical sub-systems, and which thus contribute to our knowledge of the function of these occupations, the main question in current research. The analysis methods and tools discussed here all have their own potentials and limitations. Their complementarity enables a more global consideration of the complexity of fuel management systems and contributes to our understating of human-environment interactions during the Mesolithic.

The increase of archeobotanical studies is an important step in this process, contributing to clarify the environmental context of Mesolithic occupations, with a growing number of data showing that Mesolithic groups were highly adapted and anchored to their local context. To interpret charcoal remains from a perspective broader than that of paleoecology, it is imperative that we continue to develop experimental and ethnoarchaeological reference bases.

Ethnoarchaeology enables us to think generally about the fuel management models applicable to the Mesolithic, and to consider more specifically the variability of techniques and practices and regional or individual particularities, and the manner in which these parameters participate in the definition of lifeways. This approach is closely linked to the experimental approach; it enables us to compare the evidence from modern contexts to samples produced in laboratories in order to constitute solid reference data that are then transposable to archaeological remains. The identification of the palette of fuels and firewood collecting practices through the study of archaeological remains is based on the long-term process of experimentation.

References cited

Alix C., Brewster K., 2004 - Not all driftwood is created equal: wood use and value along the Yukon and Kuskowim Rivers, Alaska, *Alaska Journal of Anthropology*, 2 (1), 2-19.

Asouti E., Austin P., 2005 - Reconstructing woodland vegetation and its exploitation by past societies, based on the analysis and interpretation of archaeological wood charcoal macroremains, *Environmental Archaeology*, 10, 1-18.

Bentley A., 2003 - An introduction to complex systems, in Bentley A., Maschner H. D. G. (dir.), *Complex systems and archaeology. Foundations of archaeological inquiry*, Salt Lake City, University of Utah Press, 9-24.

Beyries S., 2008 - Modélisation du travail du cuir en ethnologie : proposition d'un système ouvert à l'archéologie, *Anthropozoologica*, 43 (1), 9-42.

Blanchette R. A., 2000 - A review of microbial deterioration found in archaeological wood from different environments, *International Biodeterioration and Biodegradation*, 46, 189-204.

Braadbaart F., Poole I., Huisman H. D. J., van Os B., 2012 - Fuel, Fire and Heat: an experimental approach to highlight the potential of studying ash and char remains from archaeological contexts, *Journal of Archaeological Science*, 39, 836-847.

Brandisauskas D., 2007 - Symbolism and ecological usesof fire among Orochen-Evenki, *Sibirica*, 6 (1), 95-109.

Bridault A., David E., Boboeuf M., 2009 - Matter and Material: red deer antler exploitation during the Mesolithic at Clos de Poujol shelter (Aveyron, France), in Fontana L., Chauvière F.-X., Bridault A. (dir.), *In search of total animal exploitation. Case studies from the Upper Palaeolithic and Mesolithic.* Proceedings of the XVth UISPP Congress, Session C61, vol. 42, Lisbon, 4-9th September 2006, Oxford, Archaeopress (« BAR International Series » 2040), 135-154.

Brochier J.-É., Livache M., 2003 - Un faciès sédimentaire anthropique original du Mésolithique vauclusien : les terres noires à petits galets calcaires, *L'Anthropologie*, 107 (1), 153-165.

Cain C.R., 2005 - Using burned animal bone to look at Middle Stone Age occupation and behavior, *Journal of Archaeological Science*, 32, 873-884.

Caruso Fermé L., 2012 - *Modalidades y uso del material leñoso entre grupos cazadores-recolectores patagónicos (Argentina). Métodos y técnicas de estudio del material leñoso arqueológico*, Thèse de doctorat, Universitat Autònoma de Barcelona, Departament de Prehistòria, 649 p.

Chabal L., 1982 - *Méthodes de prélèvement des bois carbonisés protohistoriques pour l'étude des relations homme-végétation*, Mémoire de DEA, USTL, Montpellier, 54 p.

Chabal L., 1991 - *L'Homme et l'évolution de la végétation méditerranéenne des âges des métaux à la période romaine ; recherches anthracologiques théoriques, appliquées principalement à des sites du Bas-Languedoc*, Thèse de doctorat, USTL, 2 tomes, 435 p.

Chabal L., 1997 - *Forêts et sociétés en Languedoc (Néolihique final, Antiquité tardive), L'anthracologie, méthode et paléoecologie*, Paris, MSH, Documents d'archéologie française, 63, 189 p.

Chabal L., Fabre L., Terral J.F., Théry-Parisot I., 1999 - L'anthracologie, in Ferdière A. (dir.), *La botanique*, Collection « Archéologiques », Errance, 43-104.

Chrzavzez J., 2006 - *Collecte du bois de feu et paléoenvironnements au Paléolithique. Apport méthodologique et étude de cas : la grotte de Fumane dans les Pré-Alpes italiennes*, Mémoire de Master 2 "Environnement et archéologie", Université Paris 1, 75 p.

Chrzavzez J., 2013 - Approche expérimentale de la conservation des charbons de bois dans les gisements paléolithiques : processus post-dépositionnels, fragmentation et représentativité des assemblages anthracologiques, Thèse de doctorat, Université de Nice-Sophia-Antipolis, 459 p.

Chzravzez J., Henry A., Théry-Parisot I., Delhon C., Carré A., 2011 - Identificando prácticas de adquisición de leña: aportes de la experimentación antracológica a la cuestión del calibre de la madera usada en los hogares prehistóricos, in Morgado A., Baena J., García D. (eds.), *La investigación experimental aplicada a la arqueología*, Actas del II^{do} Congreso Internacional de arqueología experimental 26-28 noviembre 2008, Ronda, España, 205-211.

Chrzazvez J., Théry-Parisot I., Fiorucci G., Terral J.-F., Thibaut B., 2014 - Impact of post-depositional processes on charcoal fragmentation and archaeobotanical implications: experimental approach combining charcoal analysis and biomechanics, *Journal of Archaeological Science*, 44, 30-42.

Delhon C., Martin L., Argant J., Thiébault S., 2008 - Shepherds and plants in the Alps: multi-proxy archaeobotanical analysis of neolithic dung from "La grande Rivoire" (Isère, France), *Journal of Archaeological Science*, 35 (11), 2937-2952.

Delhon C., Thiébault S., 2009 - De la forêt aux foyers paléolithiques et mésolithiques dans le sud de la France : une revue des données anthracologiques et phytolithiques, in Théry-Parisot I., Costamagno S., Henry A. (dir.), *Fuel managment during the Palaeolithic and Mesolithic period. New tools, new interpretations,* Proceedings of the XVth World congress (Lisbon, 4-9 september 2006), Oxford, Archaeopress (« BAR International Series » 1914), 115-129.

Dufraisse A., 2002 - *Les habitats littoraux Néolithiques des lacs de Chalain et Clervaux (Jura, France) : Collecte du bois de feu, gestion de l'espace forestier et impact sur le couvert arboréen entre 3700 et 2500 av. J.-C. Analyses anthracologiques*, Thèse de Doctorat, Université de Franche-Comté, UFR des Sciences de l'Homme du langage et de la Société, 349 p.

Friedman J., 1974 - Marxism, Structuralism and Vulgar Materialism, *Man*, *New Series*, 9 (3), 444-469.

Gallay A., 1980 - Réflexion sur le concept d'ethnoarchéologie, *Les nouvelles de l'archéologie*, 4, 34-42.

Gallay A., 1986 - *L'archéologie demain*, Belfond, 320 p.

Gallay A., 1999 - Feu, foyer, famille : pour une paléontologie de l'espace domestique, in Golay E. (éd.), *Le feu. Feu dévorant, feu domestique, feu sacré*, Genève, Musée d'ethnographie, 49-76.

García Martínez M. S., Dufraisse A., 2012 - Correction factors on archaeological wood diameter estimation, in Badal E., Carrión Y., Macías M., Ntinou M. (dir.), *Wood and charcoal: Evidence for human and natural History*, Sagvntvm Extra, 13, Papeles del laboratorio de arqueologia de Valencia, 283-290.

Gardin J.-C., 1979 - *Une archéologie théorique*, Hachette Littérature, Paris, 339 p.

Grøn O., Kuznetsov O., 2004 - What is a hunter-gatherer settlement? An ethno-archaeological and interdisciplinary approach, in Collectif (dir.), Acts of the XIVth UISPP Congress, University of Liège, Belgium, 2-8 September 2001, The Mesolithic, C7.1, Oxford, Archaeopress (« BAR International Series » 1302), 47-53.

Guilbert R., 2001 - « Le Sansonnet » et « Les Agnels » (Vaucluse), un exemple de fragmentation thermique intentionnelle du silex au Sauveterrien, *Paleo*, 13, 245-250.

Gur-Arieh S., Shahack-Gross R., Maeir A. M., Lehmann G., Hitchcock L. A., Boaretto E., 2014 - The taphonomy and preservation of wood and dung ashes found in archaeological cooking installations: case studies from Iron Age Israel, *Journal of Archaeological Science*, 46, 50-67.

Hather J. G., Mason S. L. R., 2002 - Introduction: some issues in the archaeobotany of hunters-gatherers, in Mason S. L. R., Hather J. G. (dir.), *Hunter-Gatherer archaeobotany. perspectives from the northern temperate zone*, London, Institute of Arachaeology, University College London, 1-14.

Henry A., 2011 - *Paléoenvironnements et gestion des combustibles au Mésolithique dans le Sud-Ouest de la France : anthracologie, ethnoarchéologie et expérimentation*, Thèse de doctorat, Université de Nice-Sophia Antipolis, 2 vol., 436 p.

Henry A., Théry-Parisot I., Voronkova E., 2009 - La gestion du bois de feu en forêt boréale : archéo-anthracologie et ethnographie (région de l'Amour, Sibérie), in Théry-Parisot I., Costamagno S., Henry A. (dir.), *Fuel managment during the Palaeolithic and Mesolithic period. New tools, new interpretations*, *Proceedings of the XVth World congress (Lisbon, 4-9 september 2006)*, Oxford, Archaeopress (« BAR International Series » 1914), 13-33.

Henry A., Théry-Parisot I., 2014 - From Evenk campfires to prehistoric hearths: charcoal analysis as a tool for identifying the use of rotten wood as fuel, *Journal of Archaeological Science*, 52, 321-336.

Ingold T., 1980 - *Hunters, pastoralists, and ranchers: reindeer economies and their transformations,* Cambridge University Press, New York (London and Cambridge), 326 p.

Irbe I., Andersons B., Chirkovaa J., Kallavus U., Andersone I., Faix O., 2006 - On the changes of pinewood (*Pinus sylvestris* L.) chemical composition and ultrastructure during the attack by brown-rot fungi *Postia placenta* and *Coniophora puteana*, *International Biodeterioration & Biodegradation*, 57, 99-106.

Johannessen S., Hastorf C., 1990 - A history of fuel management (AD 500 to the present) in the Mantaro Valey, Peru, *Journal of Ethnobiology*, 10 (1), 61-90.

Joly D., March R., Marguerie D., Yacobaccio H., 2009 - Gestion des combustibles dans la province de Jujuy (Puna, Argentine) depuis l'Holocène ancien : croisement des résultats ethnologiques et archéologiques, in Théry-Parisot I., Costamagno S., Henry A. (dir.), *Fuel managment during the Palaeolithic and Mesolithic period. New tools, new interpretations*, *Proceedings of the XVth World congress (Lisbon, 4-9 september 2006)*, Oxford, Archaeopress (« BAR International Series » 1914), 35-48.

Lancelotti C., Madella M., 2012 - The 'invisible' product: developing markers for identifying dung in archaeological contexts, *Journal of Archaeological Science*, 39, 953-963.

Picornell L., Asouti E., Allué E., 2011 - The ethnoarchaeology of firewood management in the Fang villages of Equatorial Guinea, central Africa: implications for the interpretation of wood fuel remains from archaeological sites, *Journal of Anthropological Archaeology*, 30 (3), 375-384.

McParland L.C., Collinson M.E., Scott A.C., Campbell G., Veal R., 2010 - Is vitrification in charcoal a result of high temperature burning of wood?, *Journal of Archaeological Science*, 37 (10), 2679-2687.

Mallol C., Marlowe F.W., Wood B.M., Porter C.C., 2007 - Earth, wind and fire: ethnoarchaeological signals of Hadza fires, *Journal of Archaeological Science*, 34 (12), 2035-2052.

Marcoux N., 2009 - Analyse des charbons de bois de l'abri sous roche de Pont-Glas (Plounéour-Menez, Finistère), Mésolithique et second Âge du Fer, in Marchand G., Le Goffic M., *Pont-Glas (Plounéour-Menez, Finistère), second et ultime rapport de fouille programmée, année 2008*, 96-109.

Marguerie D., 1992 - *Évolution de la végétation sous l'impact anthropique en Armorique du Mésolithique au Moyen Âge: études palynologiques et anthracologiques des sites archéologiques et des tourbières associées*, Université de Rennes(« Travaux du laboratoire d'anthropologie de l'Université Rennes 1 » 40), 313 p.

Mason S.L.R., 2000 - Fire and Mesolithic subsistence-managing oaks for acorns in northwest Europe?, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 164, 139-150.

Mentzer S. M., 2009 - Bone as a fuel source: the effects of initial fragment size distribution, in Théry-Parisot I., Costamagno S., Henry A. (dir.), *Fuel managment during the Palaeolithic and Mesolithic period. New tools, new interpretations. Proceedings of the XVth World congress (Lisbon, 4-9 september 2006)*, Oxford, Archaeopress (« BAR International Series » 1914), 49-60.

Moskal-del Hoyo M., Wachowiak M., Blanchette R., 2010 - Preservation of fungi in archaeological charcoal, *Journal of Archaeological Science*, 37 (9), 2106-2116.

Mordant C., Mordant D., 1987 - Noyens-sur-Seine, site Mésolithique en milieu humide fluviatile, *L'Homme et l'eau au temps de la Préhistoire, 112e Congrès national des sociétés savantes*, Lyon, CTHS, Paris, 33-52.

Moutarde F., 2006 - *L'évolution du couvert ligneux et de son exploitation par l'homme dans la vallée du Lurin (côte centrale du Pérou), de l'Horizon Ancien (900-100 av. J.-C.) à l'Horizon Tardif (1460-1532 ap. J.-C.). Approche anthracologique*, Thèse de doctorat, Université Paris 1-Panthéon-Sorbonne, 2 vol., 509 p.

Ntinou M., 2002 - *La Paleovegetación en el Norte de Grecia del Tardiglaciar hasta el Atlántico: formaciones vegetales, recursos y usos*, Oxford, Archaeopress (« BAR International Series » 1038), 268 p.

Ntinou M., Badal E., Heinz C., 1999 - Resultados preliminares del proyecto etnoarqueológico de Sarakini (Tracia, Grecia). Comparación con la antracología prehistórica, in Collectif, *Geoarqueologia i Quaternari litoral. Memorial M. P. Fumanal*, 179-191.

Paradis-Grenouillet S., Leleu J.-P., Belingard C., Rouaud R., Allée P., 2010 - AnthracoLoJ, un outil pour la simplification des mesures dendrométriques, *Cahiers de géographie EDYTEM*, 11, 197-202.

Perlès C., 1977 - *Préhistoire du Feu*, Masson, Paris, 180 p.

Piqué R., 1999 - Quantification in archaeobotany: Charcoal Analysis and Firewood management, *New techniques for old times - CAA 986 Computer applications and quantitative methods in archaeology. proceedings of the 26th conference, Barcelona, March 1998*, in Barceló J. A., Briz I., Vila A. (dir.), Oxford, Archaeopress (« BAR International Series » 757), 189-200.

Pollard A. M., Heron C., 1996 - *Archaeological chemistry*, Royal Society of Chemistry, Cambridge, 375 p.

Ryan P. A., Blackford J., 2010 - Late Mesolithic environmental change at Black Heath, south Pennines, UK: a test of Mesolithic woodland management models using pollen, charcoal and non-pollen palynomorph data, *Vegetation History and Archaeobotany*, 19 (5-6), 545-558.

Regert M., 2004 - Investigating the history of prehistoric glues by gas chromatography-mass spectrometry, *Journal of Separation Science*, 27 (3), 244-254.

Rozoy J.-G., 1995 - Le mode de vie au Mésolithique, in Thévenin A., Bintz P. (dir.), *L'Europe des derniers chasseurs, 5e Colloque international UISPP, 18-23 septembre 1995*, CTHS, (« Documents préhistoriques » 12), 39-50.

Shackleton C. M., Prins F., 1992 - Charcoal analysis and the "Prinicple of Least Effort" - A conceptual model, *Journal of Archaeological Science*, 12 (6), 631-637.

Schulting R.J., 1998 - Creativity's coffin: innovation in the burial record of Mesolithic Europe, in Mithen S. (ed.), *Creativity in human evolution and Prehistory*, Routledge, London, New York, 203-221.

Smart T.L., Hoffman E.S., 1988 - Environmental interpretation of archaeological charcoal, in Hastorf C.A., Popper V.S. (dir.), *Current palaeoethnobotany,* Chicago / London, University of Chicago Press, 165-205.

Taborin Y., 1989 - Le foyer : document et concept, in Olive M., Taborin Y. (dir.), *Nature et fonction des foyers préhistoriques*, *Actes du colloque international de Nemours 1987*, APRAIF, Nemours, 77-80.

Théry-Parisot I., 1998 - *Économie des combustibles et paléoécologie en contexte glaciaire et périglaciaire, Paléolithique moyen et supérieur du sud de la France. Anthracologie, Expérimentation, Taphonomie*, Thèse de Doctorat, Université Paris 1, 634 p.

Théry-Parisot I., 2001 - *Économie des combustibles au Paléolithique. Expérimentation, anthracologie, Taphonomie,* CNRS Éditions (« Dossiers de documentation archéologique » 20), 200 p.

Théry-Parisot I., 2002 - Gathering of firewood during the Palaeolithic, in Thiébault S. (dir.), *Charcoal analysis: methodological approaches, palaeoecological results and wood uses. Proceedings of the 2nd International Meeting of Anthracology*, Oxford, Archaeopress (« BAR International Series » 1063), 243-249.

Théry I., Gril J., Meignen L., Vernet J.L., Maury J., 1995 - First use of coal, *Nature*, 373, 480-481.

Théry I., Gril J., Vernet J.L., Meignen L., Maury J., 1996 - Coal used at two prehistoric sites in southern France: les Canalettes (mousterian) and les Usclades (mesolithic), *Journal of Archaeological Science*, 23, 509-512.

Théry-Parisot I., Costamagno S., 2005 - Propriétés combustibles des ossements. Données expérimentales et réflexions archéologiques sur leur emploi dans les sites paléolithiques, *Gallia Préhistoire*, 47, 235-254.

Théry-Parisot I., Chabal L., Ntinou M., Bouby L., Carré A., 2010a - Du bois aux charbons de bois : approche expérimentale de la combustion, in Théry-Parisot I., Chabal L., Costamagno S. (dir.), *Taphononomie des résidus organiques en contexte archéologique. Actes de la table ronde, Valbonne, 27-29 mai 2008*, P@lethnologie, 2, 81-93.

Théry-Parisot I., Chabal L., Chrzavzez J., 2010b - Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 291 (1-2), 142-153.

Théry-Parisot I., Dufraisse A., Chzravzez J., Henry A., Paradis-Grenouillet S., 2011 - Charcoal analysis and wood diameter: inductive and deductive methodological approaches for the study of firewood collecting practices, *Sagvntvm extra*, 11, 31-32.

Théry-Parisot I., Henry A., 2012 - Seasoned or green? A new method to identify the use of green wood for fuel among archaeological charcoal, *Journal of Archaelogical Science*, 39 (2), 381-388.

Thiébault S., 2005 - L'apport du fourrage d'arbre dans l'élevage depuis le Néolithique, *Anthropozoologica*, 40 (1), 95-108.

Thibeau A., 2008 - *Stratégies d'acquisition et exploitation des ressources animales dans les niveaux mésolithiques de la grotte des Fieux (Miers, Lot)*, Rapport d'étude inédit, 19 p.

Verjux C., 2007 - Les pratiques funéraires au Mésolithique en Europe. Diversité dans l'espace et dans le temps, in Baray L., Brun P., Testart A. (dir.), *Pratiques funéraires et Sociétés, Nouvelles approches en archéologie et anthropologie sociale*, Actes du colloque interdisciplinaire de Sens, 2003, Éditions universitaires de Dijon, 15-35.

Zapata L., Cava A., Iriarte M.J., Baraybar J.P, De la Rúa C., 2002 - Mesolithic plant use in the western Pyrenees: implications for vegetation change, use of wood and human diet, in Hather J.G., Mason S.L.R. (dir.), *Hunter-gatherer archaeobotany. Perspectives from the northern template zone*, London, Institute of Archaeology, UCL, 96-107.

Zapata Peña L., Peña-Chocarro L., Ibañez Estévez J.J., 2003 - Ethnoarchaeology in the Moroccan Jebala (Western Rif): wood and dung as fuel, in Neumann K., Butler A., Kahlheber S. (dir.), *Africa praehistorica*, Köln, Heinrich-Barth-Institut, 163-175.

Auréade HENRY
Isabelle THÉRY-PARISOT
UMR 7264, CNRS, CEPAM
Campus Saint Jean d'Angély SJA3
24 avenue des Diables bleus
06 357 Nice cedex 04, FRANCE
aureade.henry@cepam.cnrs.fr
isabelle.thery@cepam.cnrs.fr


P@LETHNOLOGY
Bilingual review of prehistory