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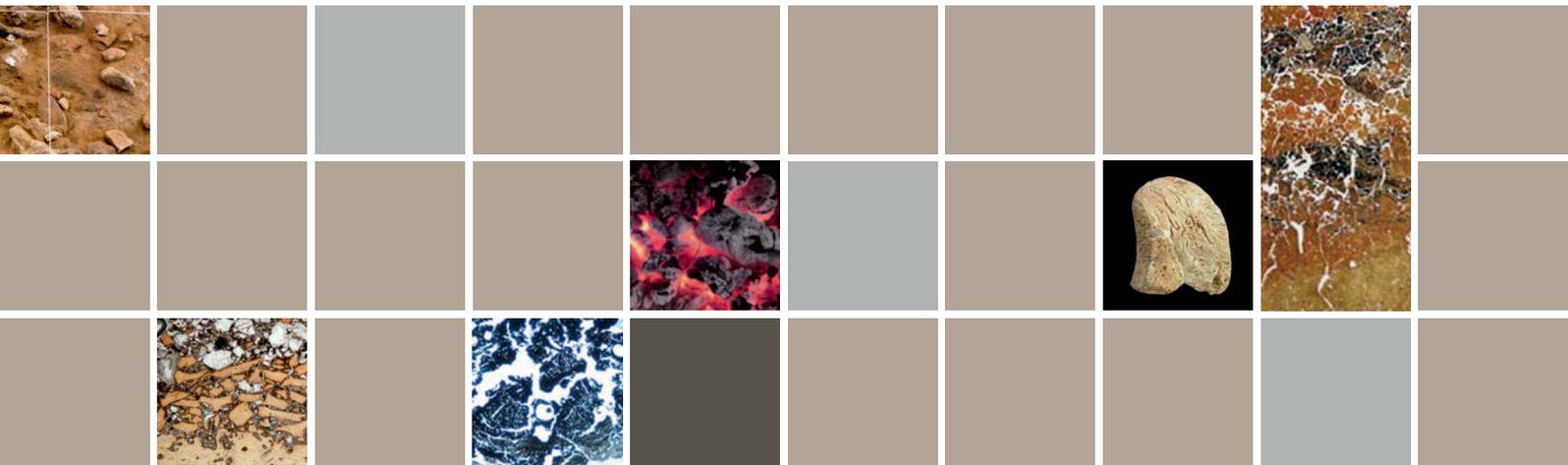
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Isabelle THÉRY-PARISOT
Lucie CHABAL
Sandrine COSTAMAGNO

**THE TAPHONOMY OF BURNED ORGANIC RESIDUES AND
COMBUSTION FEATURES IN ARCHAEOLOGICAL CONTEXTS**



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Translation

Magen O'FARRELL

Layout

Yann BELIEZ

Cover

Fabien TESSIER

The 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

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FROM WOOD TO WOOD CHARCOAL: AN EXPERIMENTAL APPROACH TO COMBUSTION

Isabelle THÉRY-PARISOT, Lucie CHABAL, Maria NTINOU,
Laurent BOUBY & Alain CARRÉ

Abstract

The anthracological deposit as it appears in archaeological contexts is the result of successive taphonomic agents intervening at many stages from the gathering of wood, to combustion and post-depositional processes. These taphonomic agents constitute successive filters between the past vegetation and the charcoal studied. Therefore, the interpretation of charcoal remains should take into account the potential deformation between the anthracological spectra and initially burned wood.

This paper presents the methodological issues and the first results of an experimental cycle whose aim was to study one of these taphonomic agents: the combustion process. Does combustion involve differential preservation of burned wood species? Does charcoal quantification reflect the real proportion of burned species? Is it necessary to define a correctional index for anthracological data?

In order to answer these questions, 110 experiments were carried out under standardized laboratory conditions and more than 295,000 charcoals were studied. Such factors as wood density or temperatures are often considered to play an active role in the fragmentation process of charcoal during combustion. As expected, the results indicate a differential behaviour of species, but one which proved to be independent of the expected factors, tending to show that the parameters that interact in the combustion process are of different nature. These factors increase the difficulty of defining a correctional index. Nevertheless, it seems that the quantification of charcoal reflects in a satisfactory manner the initial proportion of each of the burned species.

Keywords : experimentation, carbonization, fragmentation, wood charcoal, representivity

Introduction

Anthracological studies of archaeological wood charcoal are mainly based on paleoecological or economic interpretations of residues originating from incomplete wood combustions collected in archaeological sediments or fireplaces. If we believe the supposed occupation durations, these residues represent a very small proportion of the wood mass burned and probably a variable proportion depending on the nature of the sites and deposits, in other words, depending on the modes of fuel management, fire maintenance, fireplace cleaning, habitation cleaning, etc. Being ignorant of these *habitus*, we know nothing of the rate of disappearance of material from the time the wood was lit on fire until the residues were finally collected. We therefore cannot attribute any significance to the absolute quantities of wood charcoal from each species. For instance, a scarcity of residues does not necessarily indicate a scarcity of wood in the environment. Few wood charcoals are found in certain periods of the Paleolithic due to a rarity of forests or freeze/thaw cycles in the deposits; but this is also true during Antiquity because fireplaces and occupation floors were swept clean. For this reason, an anthracologist cannot reason based only on the list of taxa identified and their relative frequencies in a sample. It is necessary to know what these relative frequencies represent.

As with any archaeological assemblage, wood charcoals result from a succession of events that occur starting in their original environment until the deposits that we study. The succession of taphonomic processes that affect them can be studied in order to evaluate the degree to which the information they contain has been transformed, whether in the context of past forest environments, fire-related social and cultural practices or interactions between the economy of wood and afforestation (Chabal 1997, Théry-Parisot 2001, Théry-Parisot *et al.*, 2010). In this succession of factors, there is one, combustion, which merits closer scrutiny since it plays a major role in the disappearance of wood materials. Should we thus consider that combustion acts as a bias in the representivity of the taxa present

and modifies our image of the vegetation or any other factor that we wish to understand?

In anthracology, the measurement unit most often used to determine the frequencies of taxa is the number of wood charcoals present (Chabal, 1982, 1988; 1992, 1997; Heinz, 1990; Badal-Garcia, 1992; Bourquin-Mignot *et al.*, 1999). This quantification method requires the existence of a statistical process of fragmentation that is the same for all the taxa of an archaeological sample. Therefore, the state of fragmentation observed in an archaeological sample of wood charcoal, meaning the distribution of the individual masses of fragments, always corresponds to a Poisson distribution whose parameters depend on the method of sieving employed, but not the taxon considered (Chabal 1989, 1992, 1997). This permits us to affirm that the unit constituted by “one wood charcoal” has a meaning in statistical terms and allows us to compare different taxa, in other words, to express their relative frequencies. A specific question that interests us here is the following: are the frequencies of taxa expressed in this manner a valid expression of their frequencies among the intentionally burned wood materials? In effect, fragmentation and mass reduction are two processes that are simultaneous, but independent in their results. Until now, anthracology has been based on the hypothesis that all species behave in the same manner in an identical fire in terms of mass reduction: in other words, the ratio of proportionality between the quantity of wood charcoal and the quantity of wood burned would be identical for all species. This hypothesis is founded on (i) the reproducibility of frequency spectra between synchronous levels of the same site—this would not be the case if the combustion created a variable distortion of the frequency of taxa—and (ii) the paleoecological representivity of archaeological samples of wood charcoal and the coherence of anthracological diagrams between themselves and through time—this would not be the case if the hierarchy between dominant taxa and subordinate taxa was modified by a differential mass reduction. The existence of a single statistical law of fragmentation for all taxa justifying our unit of measure is largely demonstrated (since it is based on observed



archaeological samples). Inversely, the hypothesis according to which all species behave in the same manner in an identical fire is still justifiably questioned since it has not yet been experimentally validated. Therefore, probably due to the complexity of their realization, quantifications of the frequencies of taxa following experimental combustions are few and sometimes present discordant results, which merit discussion.

Starting in the 1970-80's, experiments addressing the processes of fragmentation and the reduction of the mass of burned wood have been conducted. The results of these experiments vary greatly, however, depending on the authors who generally opposed the intrinsic and extrinsic variables of combustion as factors determining the proportions of residues. According to some researchers, the proportions of residues depend on the physical, chemical and mechanical properties of the species in question (Rossen & Olson, 1985; Smart & Hoffman, 1988; Loreau 1994; Braadbaart and Poole, 2008), while others defend the predominant role of extrinsic variables (type of combustion feature, temperatures, oxygenation) (Scott & Jones, 1991; Belcher *et al.*, 2005; Vaughan & Nichols 1995). Rossen and Olson (1985) argue that low density woods produce less charcoal than hard woods, but Loreau (1994) believes the opposite is true. According to this latter author, a high humidity level in the wood clearly reduces the proportion of residues, while our own results tend to minimize the role of this parameter (Théry-Parisot *et al.*, 2010). For some authors the caliber of the wood determines the proportion of residues (Smart and Hoffman, 1988). Lingens *et al.* (2005) suggest that the differences in the proportion of remains are more closely linked to the chemical composition of wood than to its density. The work of Belcher *et al.*, (2005) and Scott & Jones (1991) indicates that the proportions of residues reflect a concomitant effect of the combustion temperature and oxygenation. Finally, according to Vaughan & Nichols (1995), the temperature attained in a fireplace determines the size, density and morphology of the residues.

Faced with these diverging results and in the context of a broader exploration of taphonomic factors, it appeared

useful to us to pursue and develop analytic approaches to combustion.

- Do different species behave differently when burned?
- Is there an over or under-representation of certain taxa following combustion?
- What are the experimental variables that determine the behavior of fuel materials in fire?
- Can we and should we define correction indices of the frequencies of taxa that can be used in anthracology?

Experimentation is the most appropriate method for addressing these types of questions.

Experimentation: procedure and protocol

The experiments were realized in an open fireplace under laboratory conditions in order to limit the known effects of external factors (wind, atmospheric humidity, fireplace form, etc.) on the combustion process (fig. 1). The form, size and maintenance of the fire of course have a direct effect on its thermal behavior and, consequently, on the residues themselves. But there exist so many possible combinations that it would be illusory to think that we are capable of experimentally reproducing all past situations. Therefore, by eliminating (to the greatest degree possible) all variation linked to external factors and by standardizing the experiments as much as possible, the impact of a combustion process on its combustibles can be studied independently of the technical gestures. With an understanding of the effects of combustion, and in particular the behavior of different species in a fire, it will then be possible to consider the over-representation of a taxon due to other causes, such as the form of the fireplace or the practices and gestures related to the use of fire. Given that these aspects are of great interest to us, and that we must not risk false interpretations of them, it is all the more clear that the combustion process must be known beforehand.

The experiments (fig. 2) were conducted with eleven taxa commonly represented in anthracological assemblages: *Quercus pubescens*; *Betula pubescens*;



Olea europea; *Corylus avellana*; *Carpinus betulus*; *Ostrya carpinifolia*; *Pinus pinaster*; *Pinus halepensis*; *Pinus sylvestris*; *Populus alba*; *Populus tremula*. In order to account for intra-specific variability, the lots of each taxon were collected from two geographically distinct sources (except for *Populus alba*, *Populus tremula*, *Carpinus betulus* and *Ostrya carpinifolia* for which only one source was sampled). The wood was unsplit, dry and had a humidity level between 12 and 14%. Prior to combustion, the characteristics of the logs within each lot were recorded (mass, volume, surface, caliber and humidity level).

All of the combustions were realized following a strictly identical protocol: each fireplace was composed of 6 calibrated logs and was constructed and maintained in an identical manner (fig. 1). Each fire was lit using a blowtorch to avoid introducing small caliber wood fragments.

For each taxon and each source, 6 combustion replicas (or sometimes only 5) were realized in order to control

and record the variability of similar experiments, called “intra-individual” variability.

In an open structure, temperature is a highly fluctuating measure that is conditioned by the position of the sensor in the fireplace and a high number of sensors are thus necessary to obtain an exploitable measure. The temperatures were thus simultaneously recorded using 12 sensors distributed within the fireplace. The total duration and the duration of combustion with flames were also recorded. After the combustion, all of the residues were sieved with four meshes in order to separate five fractions (>4 mm, 2 to 4 mm, 1 to 2 mm, 0,5 to 1 mm and < 0,5 mm), which were weighed and counted (for the >4 and 2 to 4 mm classes). The ashes were reserved for a quantitative study of the phytoliths (Delhon, this volume). The results we present here concern 110 combustions, represented by 295,688 residual wood charcoals. In this paper, we present the results of the analysis of residues greater than 2 mm (2 and 4 mm sievings).

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Fig. 1 - Experimental combustion structures: from wood to wood charcoal.

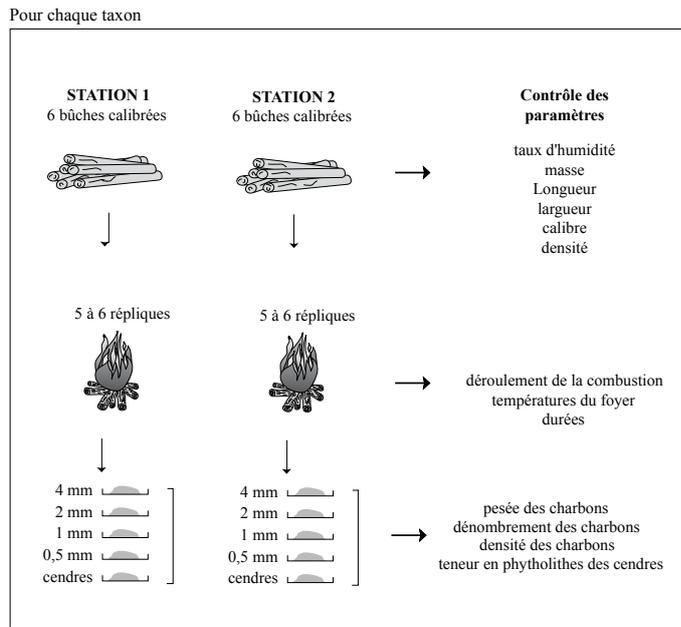


Fig. 2 - Experimental protocol.

Is the number of residual charcoal fragments dependent on the quantity of wood burned?

The first factor measured was the relationship between the quantities of wood put into the fires, expressed as a volume, and the residual number of wood charcoal fragments, expressed as the number of fragments: is the residual number of wood charcoals proportional to the quantity of wood put into the fire, regardless of the taxon considered? We express the quantity of wood as a volume since the combustions were realized with logs lots having the same volume¹, but a highly variable mass depending on the density of the species². Reasoning in terms of wood masses would thus have meant working with fires that were not standardized between species and whose measures would thus not be comparable.

In figure 3, each point represents a combustion and indicates that the number of charcoals logically tends to increase with the volume of wood, but the regression shows the statistical independence of this relationship ($R^2=0.04$): the number of wood charcoals is not dependent on the quantity of wood put into the fire when

¹ - Stabilizing the volume of wood and the caliber of the logs is important in order to standardize the aeration of the fire, which would not be possible with log lots of equal masses.

² - It is for this reason that firewood is commercially sold by the cubic meter and not by the ton.

³ - Number of wood charcoals over 2 mm over the initial volume of wood.

the parameters of species and source are varied. It is therefore not possible to deduce the quantity of wood burned in a fire based on the quantity of charcoal found in an archaeological context. We can remark that this lack of correlation between the quantity of wood burned and the quantity of carbonized residues is demonstrated under standardized combustion conditions; it is thus *a fortiori* true and certainly even more significant under real conditions where parameters such as fire aeration, the caliber of the wood pieces and the form of the combustion structure may vary. On this graph, we can observe a clustering effect: the grouping of points of the same color, which represent a single taxon individualized according to its source, shows the reproducibility

of the measure, indicating that the replicas within a single experiment behave in a nearly identical manner. This reproducibility of results tends to validate the protocol and suggests the existence of a correlation between the taxa and the residual number of wood charcoals.

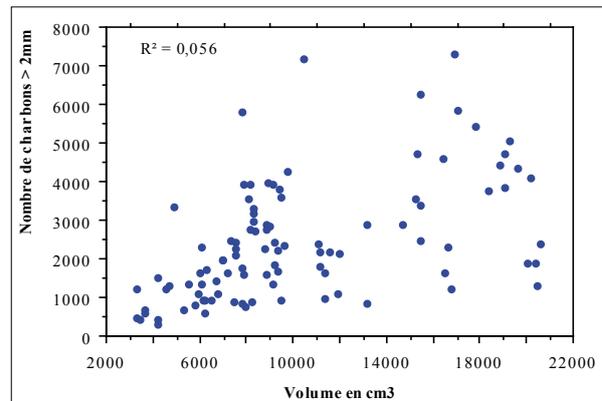


Fig. 3 - Relationship between the volume of wood put into a fire and the number of residual wood charcoals >2mm.

Source variability

The results of our experiments are expressed as proportions of residues in order to standardize and allow comparisons of the experiments³ (fig. 4).



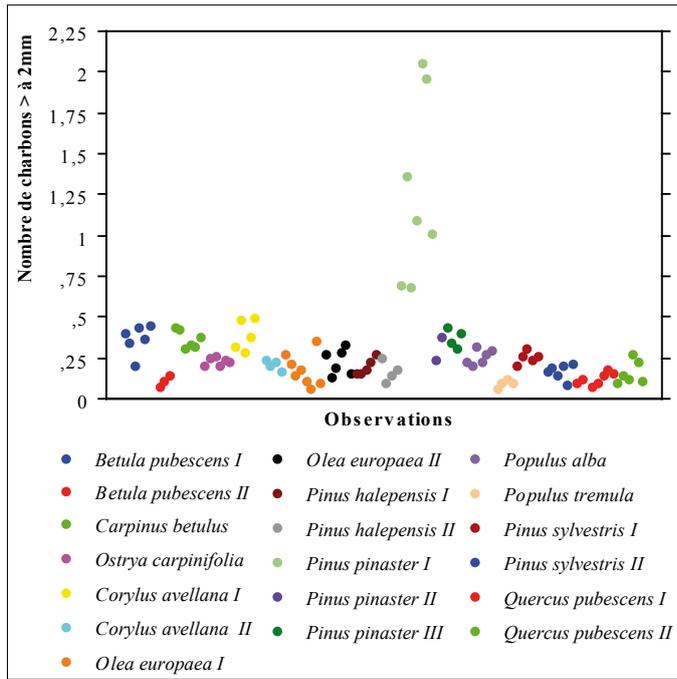


Fig. 4 - Projection of the number of wood charcoals >2mm for each source.

According to the graph, the replicas within a single experiment produce very similar results for 18 of the 19 sources tested⁴. Only the *Pinus pinaster* I station is distinguished by a clearly higher residue proportion and significant variations between the replicas. Except for *Pinus pinaster* I, the reproducibility of the measure in the replicas for 18 sources (10 species) validates the experimental results. The variability among the sources is evaluated through a comparison of the results obtained for the two sampling sources of each species (fig. 5). On each graph, the average proportion of residues for the two sources is represented. The source variability is not significant for *Quercus pubescens*, *Olea europaea* and *Pinus halepensis*, the two lots leaving an equivalent average proportion of residues. Inversely, it is significant for *Pinus*

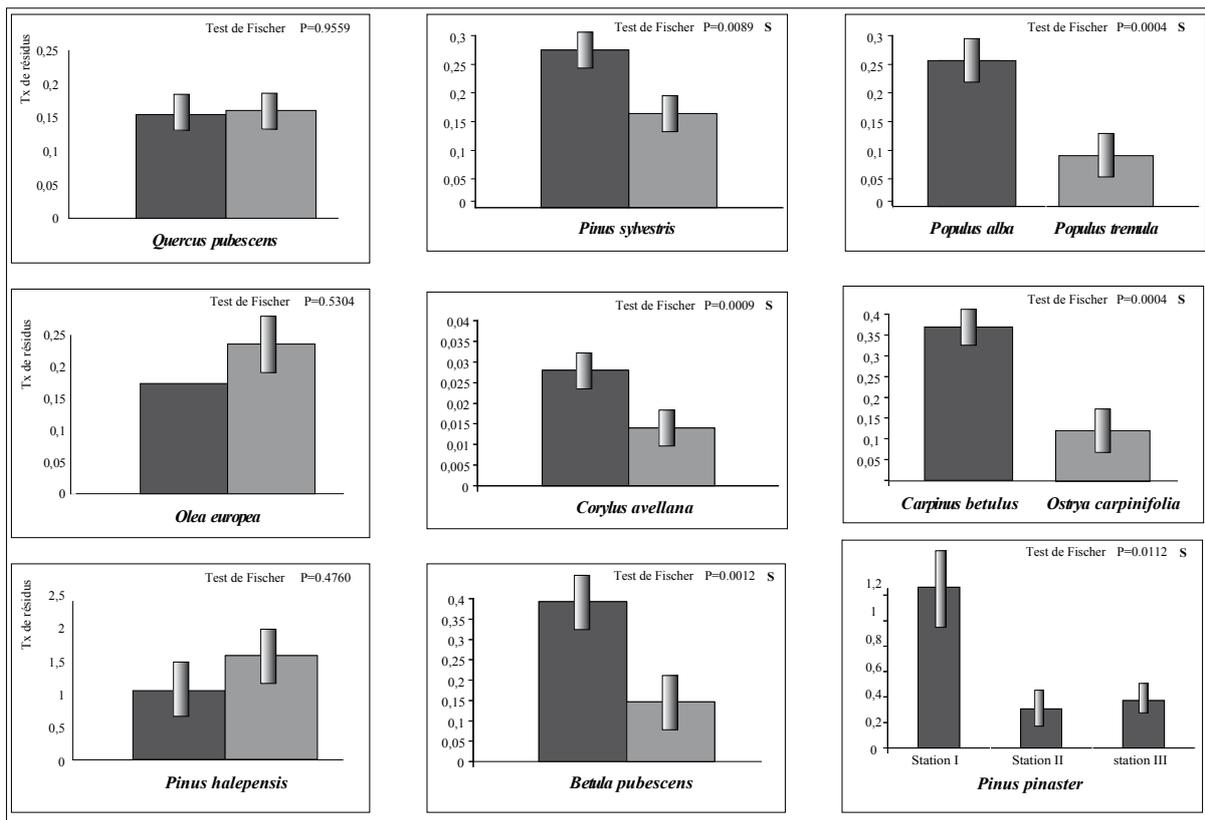


Fig. 5 - Variance analysis of the proportion of wood charcoals >2 mm “source effect”.

⁴ - The points of the same color represent the replicas within a single experiment, meaning all of the experiments realized for a taxon with the same geographic origin (source).



sylvestris, *Corylus avellana* and *Betula pubescens*, which present a variable proportion of residues depending on the source. This variability could be due to factors of environmental growth, which may have determined certain characteristics of the wood that could have an influence on its behavior when burned. For example, it is possible that source variations in the density or chemical composition of wood are determinant in this “environmental” variability.

Finally, three taxa raise particular problems. The *Pinus pinaster* I station presents an abnormal dispersion of the residue proportions in six of the experiments realized. A new series of six experiments conducted with the lots originating from a third source confirm the abnormal behavior of the *Pinus pinaster* I (PpI) lot. Contrary to source I, sources II and III present residue proportions that are comparable and coherent with the other results (they remain within the scatter plot). A rapid microscopic observation of the residual charcoals shows that the bark of PpI represents a high proportion of the residues analyzed⁵. However, (i) bark is often poorly represented in anthracological assemblages, (ii) and when it is, it is rarely possible to determine the species. It would thus be necessary to recalculate the residue proportions without the bark so that it represents only the identifiable charcoals, which was not possible due to the very high number of remains (9.500 fragments). Therefore, the source variability of *Pinus pinaster* could be (i) real, but remains to be determined, and/or (ii) result from a quantification bias due to the over-representation of bark. Since we do not yet have a response to this question, the data from the PpI source are excluded from this study and only sources II and III are taken into account. In addition, the source variability could not be evaluated for the *Populus* and *Carpinus* lots due to a problem during the procurement of the wood: the *Populus* lots originate from two species *P. alba* and *P. tremula*. However, these two groups present statistically distinct residue proportions. Similarly, the two *Carpinus betulus* sources, which are also discriminated by their residue proportions, correspond in reality to one

Carpinus betulus source and one *d'Ostrya carpinifolia* source. Consequently, lacking a comparison source, it is not possible to reach a conclusion concerning the source variability of *Populus alba*, *Populus tremula*, *Carpinus betulus* and *Ostrya carpinifolia*. At most, we assume the existence of a taxonomic variability (intra-generic for *Populus*, specific for the others).

According to our results, the source variability, though it clearly exists, is not constant for all the species analyzed. The question of specific variability is then raised. If the inter-specific variability is greater than the intra-specific variability (source), this latter can be considered negligible and the residue proportion must be analyzed as a variable related to the species. If the intra-specific variability is greater, on the other hand, we must conclude that there is no average species/genus behavior, but rather a high variability of behavior in fire of populations, of an environmental nature, within a single taxon.

Specific variability

Figure 6 shows the proportion of residues recorded for each taxon, with the two sources of each species now being grouped, except for the *Carpinus betulus* and *d'Ostrya carpinifolia* and *Populus alba* and *Populus tremula* lots, each of which originate from only one source (see above).

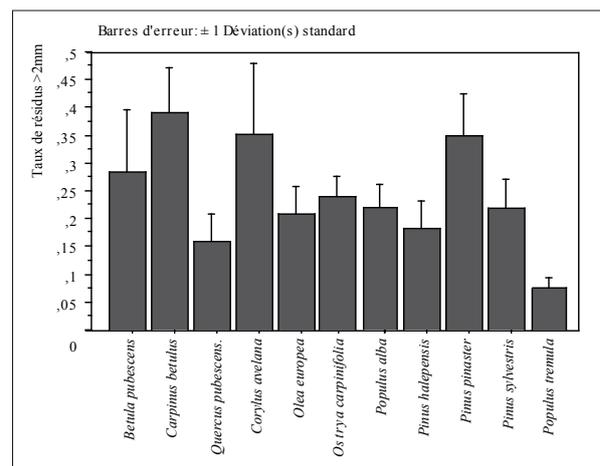


Fig. 6 - Variance analysis of the proportion of wood charcoals >2 mm “species effect”.

⁵ - Observations of the characteristics of the wood lots of source I also show that the bark is very thick (average 3.5 cm).

Variance analysis shows that, despite source variability, the species “effect” is significant with a value of $p < 0.0001$. Three groups of taxa are statistically discriminated ($F= 23.8$; $p < 0.0001$) (fig. 7). Group 1, composed of *Betula pubescens*, *Carpinus betulus*, *Corylus avellana* and *Pinus pinaster*, leaves on average more residues than the two other groups ($TR_{es} = 0.334$). Group 2, composed of *Pinus sylvestris*, *Olea europea*, *Populus alba* and *Ostrya carpinifolia*, has an average residue proportion ($TR_{es} = 0.222$) that is close to the statistical average ($TR_{es} = 0.248$). Group 3, composed of *Pinus halepensis*, *Quercus pubescens* and *Populus tremula*, leaves, on average, fewer residues than the two other groups ($TR_{es} = 0.155$). Group 1 leaves on average two times more residues than group 2.

This signifies that, after combustion, and if we refer to group 2 (*Pinus sylvestris*, *Olea europea*, *Populus alba* and *Ostrya carpinifolia*), for which we can say that the burning behavior is close to the statistical average, the *Betula pubescens*, *Carpinus betulus*, *Corylus avellana* et *Pinus pinaster* taxa are over-represented in the number of wood charcoals, while *Pinus halepensis*, *Quercus pubescens*, *Populus tremula* and *Ostrya carpinifolia* are under-represented.

These results reveal specific variability in the residue proportions whose cause must now be analyzed: why are the effects of combustion different for close species? How can we explain, for example, that the variability of residue proportions is so high between two species of the same genus (cf. *Populus alba* and *P. tremula*, *Pinus pinaster* and *P. halepensis*)?

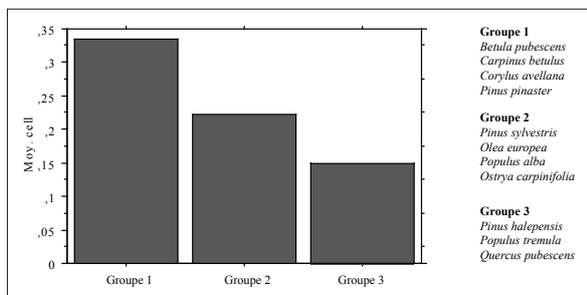


Fig. 7 - Variance analysis of the taxa “group effect”.

The effect of density

We first considered the effect of wood **density**, which some authors believe could have an influence on residue proportions (Loreau, 1994; Rosen & Olson, 1985). In effect, the density, via the porosity, is related to the inflammability of wood. Figure 8 shows the residue proportions and average density of each taxon. We observe that the density has no clear relationship with the residue proportions with a coefficient of determination that is nearly null ($R^2 = 0.04$). For example, *Quercus pubescens* and *Carpinus betulus*, which are both high density wood, are represented in the extreme groups (1 and 3). The same is true for *Populus tremula* and *Pinus pinaster*, which are both low density woods. Even more so, *Populus tremula* and *Populus alba*, whose theoretical density is nearly the same, have very different residue proportions (fig. 9). This factor thus does not explain the species specific residue proportions.

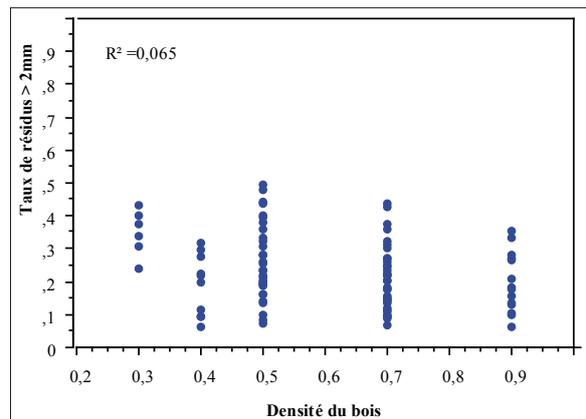


Fig. 8 - Regression of wood density vs proportion of wood charcoals >2mm.

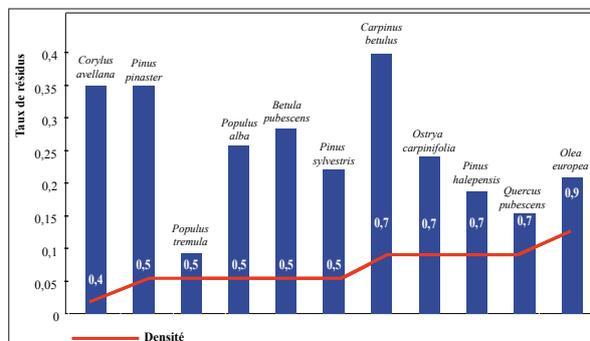


Fig. 9 - Residue proportions and wood density.



The effect of the taxonomic proximity of the species

Among the four species of group 1 (high residue proportions), three present evident anatomical similarities (*Betula pubescens*, *Corylus avellana* and *Carpinus betulus*) (Schweingrüber, 1978). The genera *Betula*, *Corylus* and *Carpinus* are in fact currently classed in the same family, the Betulaceae. Group 2 (low residue proportions), on the other hand, are composed of both Gymnosperms (conifers) and Angiosperms (hardwoods). Furthermore, the three species of the genus *Pinus* are not represented in the same group. Therefore, if the **anatomy**, or even chemistry (also linked to the taxon), of wood had an influence on its burning behavior, why aren't the species with the greatest number of taxonomic affinities in the same group? It thus appears that the burning behavior of the different species is not linked to a simple relationship with the anatomy of the wood considered from the perspective of taxonomic affinity.

The effect of temperatures

The recording of **temperatures** during combustion allows us to address the recurring question of the relationship between temperature and the proportion of residues. A regression analysis shows the independence of these two variables ($R^2=0.1$) (fig. 10). The maximal average temperatures recorded, which vary in our experiments from 780 to 916°C, are independent of the residue proportions (fig. 11). There is thus no

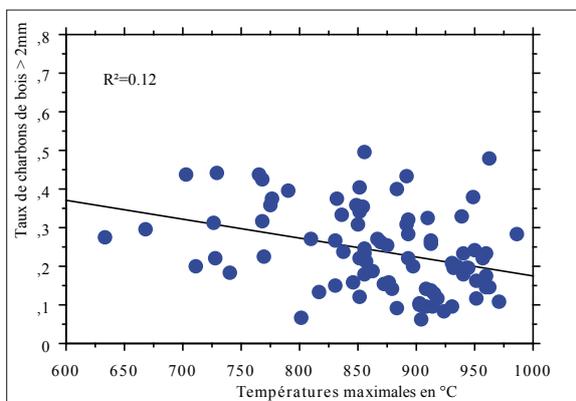


Fig. 10 - Regression of maximal temperatures vs proportion of wood charcoals >2mm.

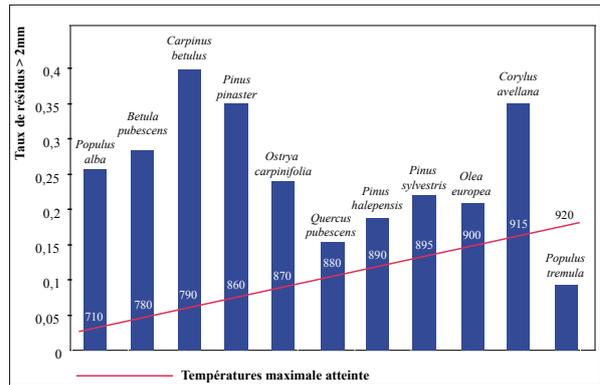


Fig. 11 - Residue proportions and maximal temperatures attained during combustion.

relationship between the temperature curve of a species and its residue proportion. In addition, we can question the pertinence of this measure, which, even if it consists of an average calculated from 12 sensors per combustion, can vary from 100 à 200°C on average depending on the position of the sensors within the structure.

The effect of the combustion duration

In our experiments, the combustion **duration** varied from 4 to 15 hours with no relationship between the quantity of wood put into the fire and the total duration (fig. 12) ($R^2=0.033$).

The combustion duration varied little from one taxon to another with the exception of *Carpinus betulus* and *Quercus pubescens*, which have longer combustion durations (fig. 13). However, the residue proportion of *Quercus pubescens* is the lowest, while that of *Carpinus betulus* is one of the highest. The variable of the combustion duration of each species thus does not explain its residue proportion.

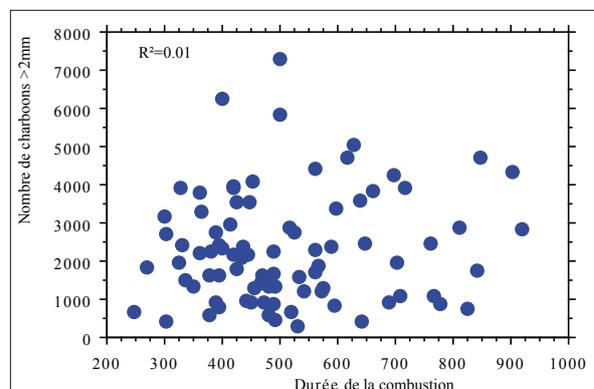


Fig. 12 - Regression of combustion duration vs proportion of wood charcoals >2mm.



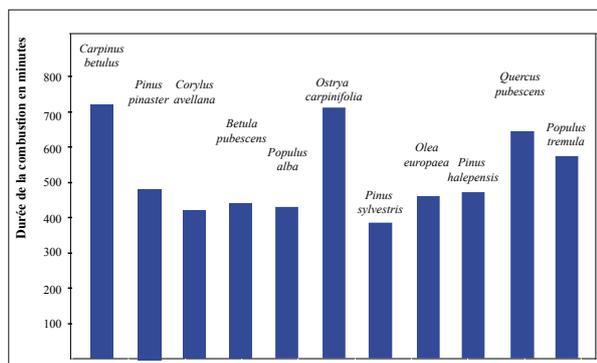


Fig. 13 - Residue proportions and combustion duration.

Discussion and conclusions

Our results appear to be validated by the reproducibility of measures within the same experimental modalities. They show that (i) the proportion of residues is not due to a simple proportional relationship with the quantity of wood put into a fire, even under standardized combustion conditions; (ii) that the behavior of different sources (intra-specific variability) in a fire is random, and; (iii) that there is an inter-specific variability that discriminates three groups of taxa. This specific variability is not explained by any of the variables tested (density, anatomical proximity, temperatures or combustion duration). These experiments thus underline the difficulty of detecting a relationship between variables whose influence appears *a priori* clear, and the proportions of residual wood charcoals. For example, temperatures, combustion durations, or wood density for the two *Populus* species (*P. alba* et *P. tremula*) clearly show a statistic independence between wood density and residue proportions.

In order to understand the relationship of taxon/residue proportion, it will be necessary to consider other variables whose influence is seemingly less evident than those tested, such as microporosity⁶, chemical composition or a global thermal synthesis that is not limited to the optimal temperatures. The groups identified are opposed relative to the statistical average, with some taxa tending to be over-

represented (*Carpinus betulus*, *Betula pubescens*, *Corylus avellana* and *Pinus pinaster*) and others under-represented (*Quercus pubescens*, *Populus tremula* and *Pinus halepensis*). But what about the “real” proportionality, meaning one that compares all of these data? In our analyses, the representation of residues is evaluated relative to a statistical average that is calculated based on the individual data (replicas) of each taxon. The Anova test evaluates the dispersion of each taxon around this statistical average. But another possibility is to globally evaluate (all experiments together) the relationship between the initial proportion of wood burned for each taxon and the proportion of residual charcoals. This consists of nothing more than an anthracological diagram presenting the *pre*- and *post*-combustion proportions (fig. 14). These species were of course not burned together and this is only a graphic representation.

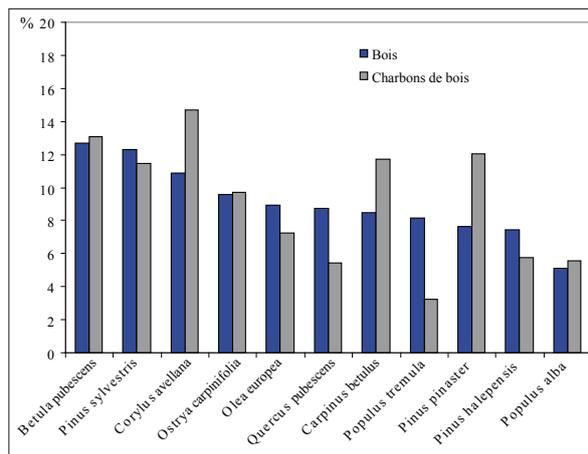


Fig. 14 - Proportionality relationship between the quantity of wood put into a fire and the quantity of residual wood charcoals.

We observe that the proportionality ratio is respected for six of the eleven taxa analyzed (difference < 2%): *Betula pubescens*, *Pinus sylvestris*, *Ostrya carpinifolia*, *Olea europaea*, *Pinus halepensis* and *Populus alba*. Three taxa are over-represented (*Corylus avellana*, *Carpinus betulus* and *Pinus pinaster*), while two are under-represented (*Quercus pubescens* et *Populus tremula*).

⁶ - The porosity of wood could be measured by the density of the vessels and the vascular conductivity, two variables that are considered in quantitative ecoanatomy, and which vary according to the species and climatic parameters (source variations) (Bourquin-Mignot *et al.*, 1999, p. 101).

Therefore, the proportions of wood charcoals are generally an accurate reflection of the initial proportions of species put into a fire and there is no inversion of majority or minority values. We should nonetheless note that the residue proportions of a few taxa are poor reflections of the proportion of wood put into a fire. In addition, these results do not integrate the potential and probable interactions that would occur between different species if they were burned together.

In archaeological contexts, there is also the question of the anatomical distinction of species whose behavior in a fire is not similar. For example, though it is theoretically possible, the anatomical discrimination between *Pinus pinaster* and *P. halepensis* can sometimes be problematic. The same is true for *Populus alba* and *Populus tremula*, which though they were discriminated in our experiments, are anatomically comparable. It would thus be difficult to evaluate the quantitative representivity of these taxa based only on our experiments.

The results we have presented here remain incomplete and many other observations must be realized based on the same data. For example, there is the question of the representivity of different size classes of wood charcoals, separated by different mesh sizes in a sieving column. Does one of the fractions better represent the initial proportion of each species burned? The data were analyzed here in a global manner (fraction above 2 mm) even though our data would allow us to treat the $N > 4$ mm and $2 < N < 4$ classes separately. Furthermore, the expression of residues in terms of mass, rather than as the number of fragments, was not addressed. Therefore, questions related to the relationship between the number and mass of residual charcoals, the representivity of these two measures and the proportional relationship between the volume of wood burned and the residual mass of wood charcoal, remain unanswered. Our results should also be compared with those of combustions realized in outside, in open-air conditions—or inside but with the introduction of variables such as

a controlled aeration of the fire—in which extrinsic factors dominate over intrinsic factors and could override and nullify the effects recorded in our experiments.

To finish, we must remember that considering combustion as a possible agent in the distortion of anthracological diagrams is not sufficient. It is of course necessary to integrate the impact on assemblages of wood gathering practices before combustion and depositional and post-depositional processes after combustion. Meanwhile, in our current state of knowledge, experimental measures addressing the differential behavior of species are rare. Research in progress on this subject should greatly contribute filling this void.

Authors

Isabelle Théry-Parisot & Alain Carré

Centre d'étude Préhistoire, Antiquité, Moyen Âge (CEPAM UMR 6130 CNRS), 250 rue Albert Einstein, 06560 Valbonne, France.

they@cepam.cnrs.fr

carre@cepam.cnrs.fr

Lucie Chabal & Laurent Bouby

Université Montpellier 2, Centre de Bio-Archéologie et d'Écologie (CBAE UMR 5059 CNRS), Institut de Botanique, 163 rue A. Broussonet, 34090 Montpellier, France

chabal@univ-montp2.fr

laurent.bouby@univ-montp2.fr

Maria Ntinou

Department of Management of Cultural Heritage and Technologies, Ioannina University, Greece.

maria.ntinou@uv.es

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