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Charcoal analysis of kiln terraces to reconstruct practices and wood uses' temporalities for charcoal manufacturing activity: the case of the Bernadouze forest (Suc-et-Sentenac, Haut-Videssos)

7th international anthracology meeting in Liverpool from 2-6 September 2019

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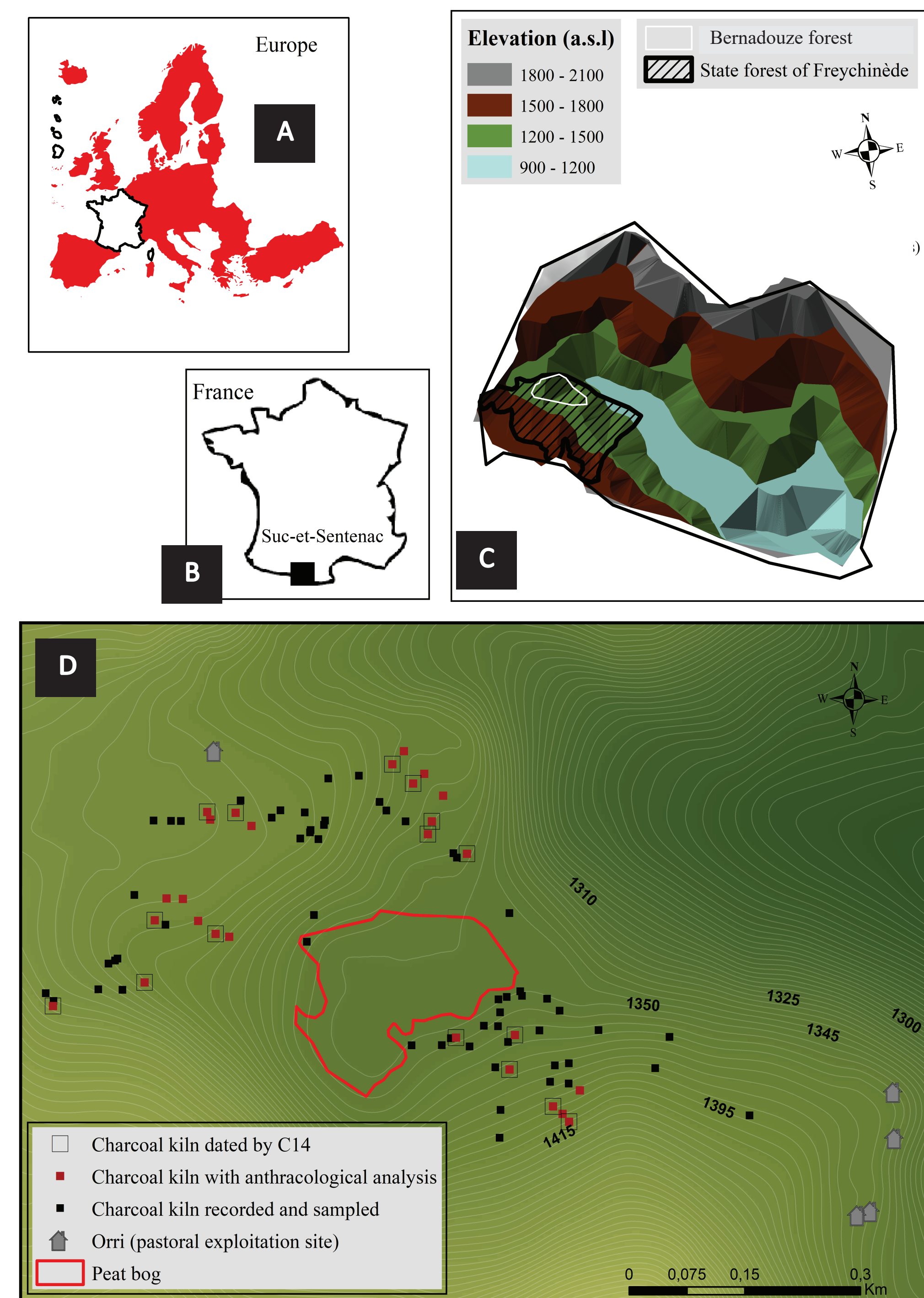


Fig.1: Localisation of study area. A: Europe, B: National, C: Valley, D: Forest study area

Context and objectives

This poster presents the results of the anthracological analysis of 7990 charcoals collected from 28 charcoal kilns located between 1300 and 1500 m ASL in the Bernadouze forest (french Pyrenees). This study aims to reconstruct the specific practices and temporalities of wood use in relation to charcoal making activity. It's based on the analysis of the most frequently occurring bioindicators preserved in charcoals from archaeological context.

Material and method

- Charcoal kilns: inventory and sampling of 80 terraces (Fig. 1 and 2) ;
- Anthraco-analysis (taxonomic determination) of the charcoals from 28 terraces and 18 radiocarbon dating;
- Research and characterisation of bio-indicators: (A) quantifying the contamination (hyphae) by fungi according to an alteration gradient ranging from unaltered to very altered (3 levels) (Fig. 3A, 3B and 3C) and (B) cellular collapse (presence/absence) (Fig. 4A and 4C); (C) counting the radial cracks (number of FRR/cm²) (Fig. 5), (D) observing the position of the bark in the last growth ring (Fig. 6);
- Study and comparison of historical documents with archeological and anthracological data.



Fig. 2: Sampling of charcoal kiln

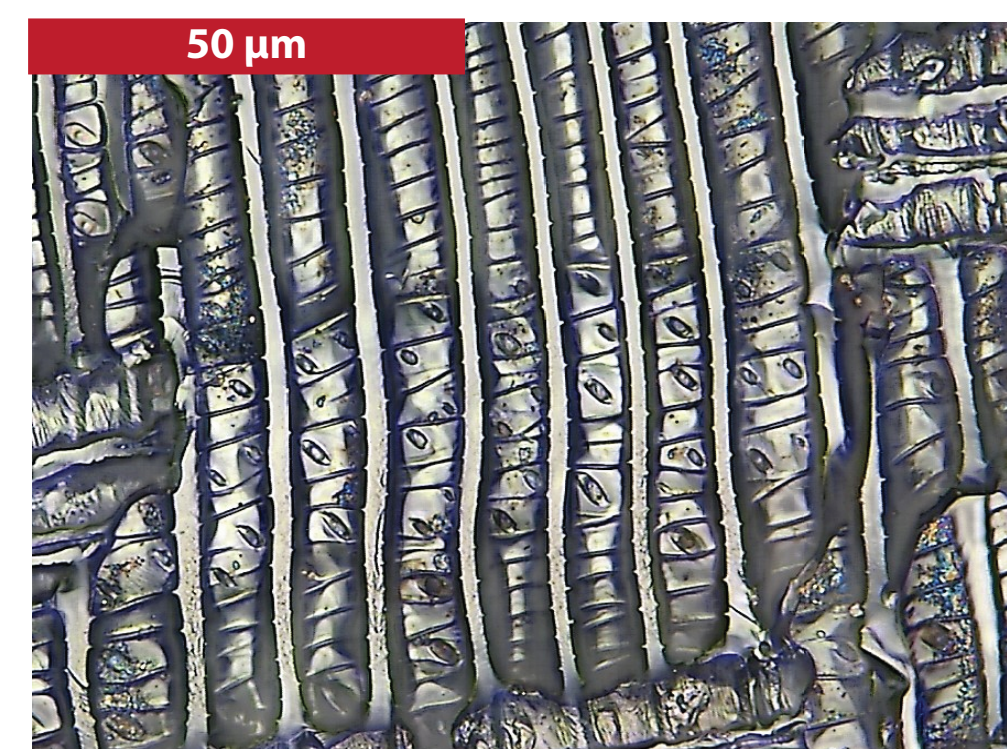


Fig. 3A: Hyphae fungi level 0 (none) - *Taxus baccata* -

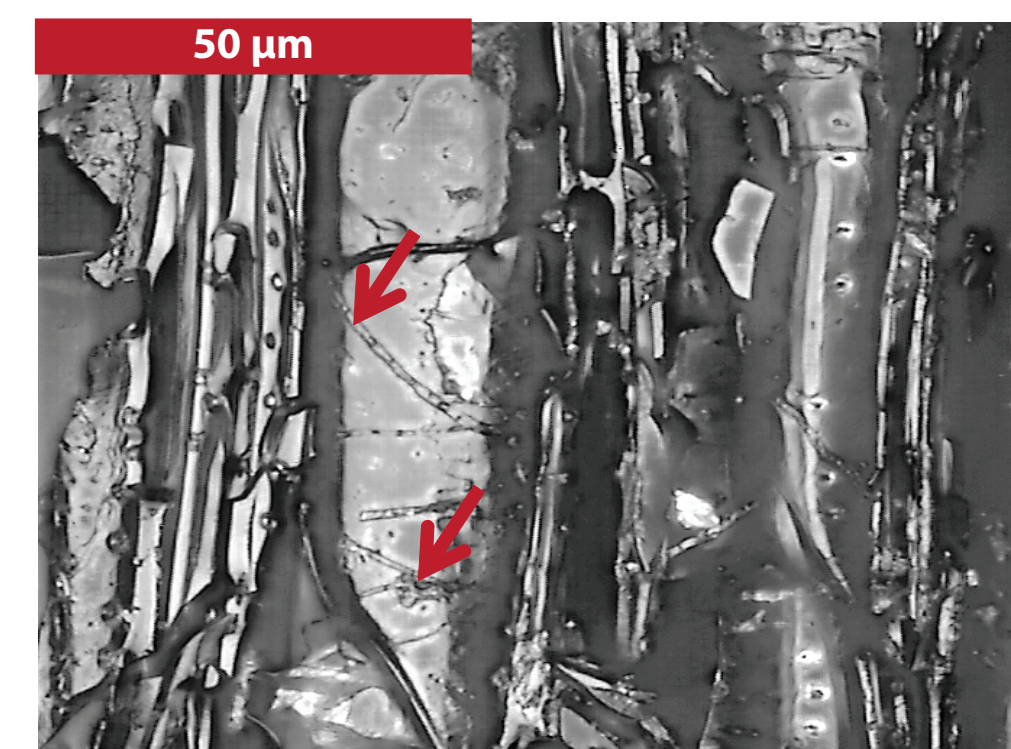


Fig. 3B: Hyphae fungi level 1 (low) - *Fagus sylvatica* -

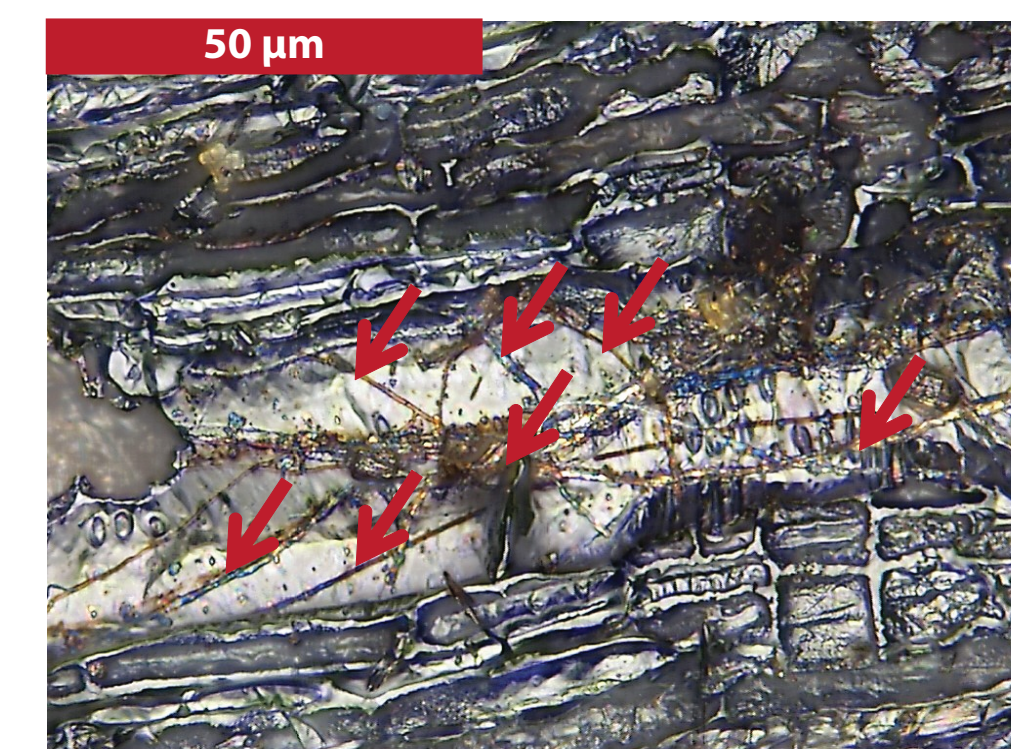


Fig. 3C: Hyphae fungi level 2 (high) - *Fagus sylvatica* -

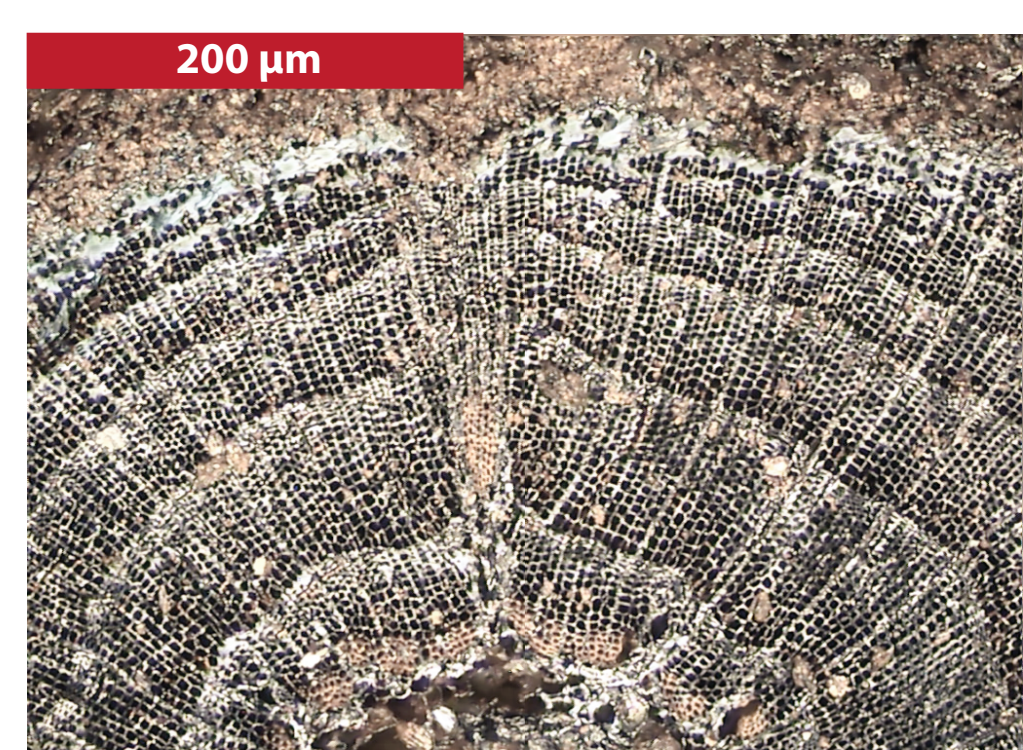


Fig. 4A: Cellular collapse absent - *Abies alba* -

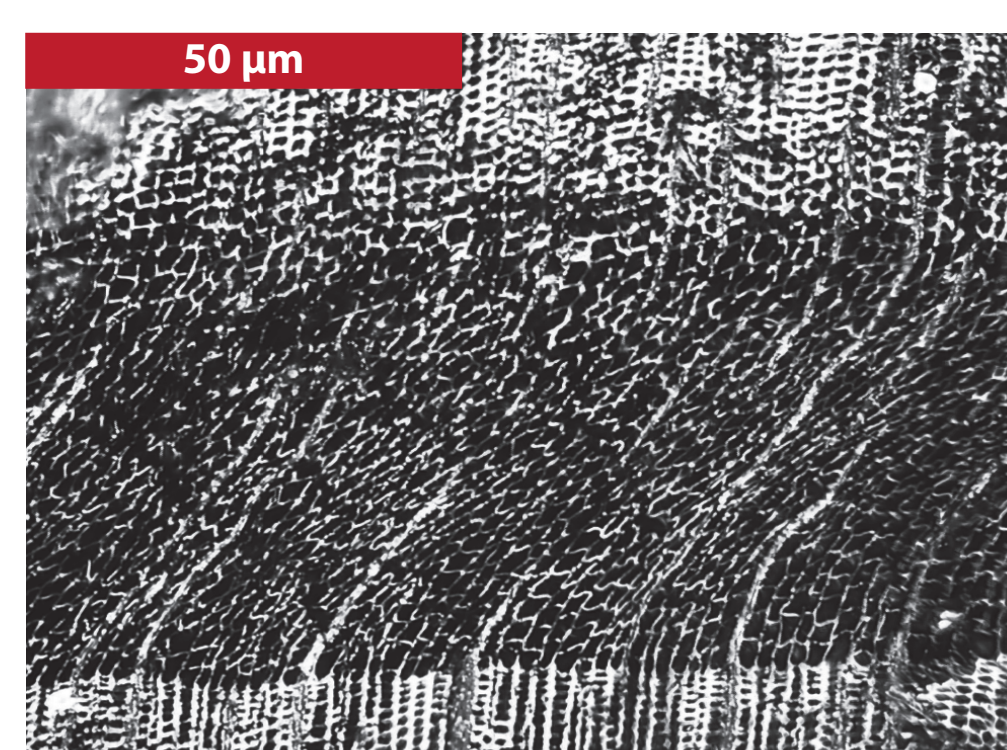


Fig. 4B: Cellular collapse present - *Abies alba* -

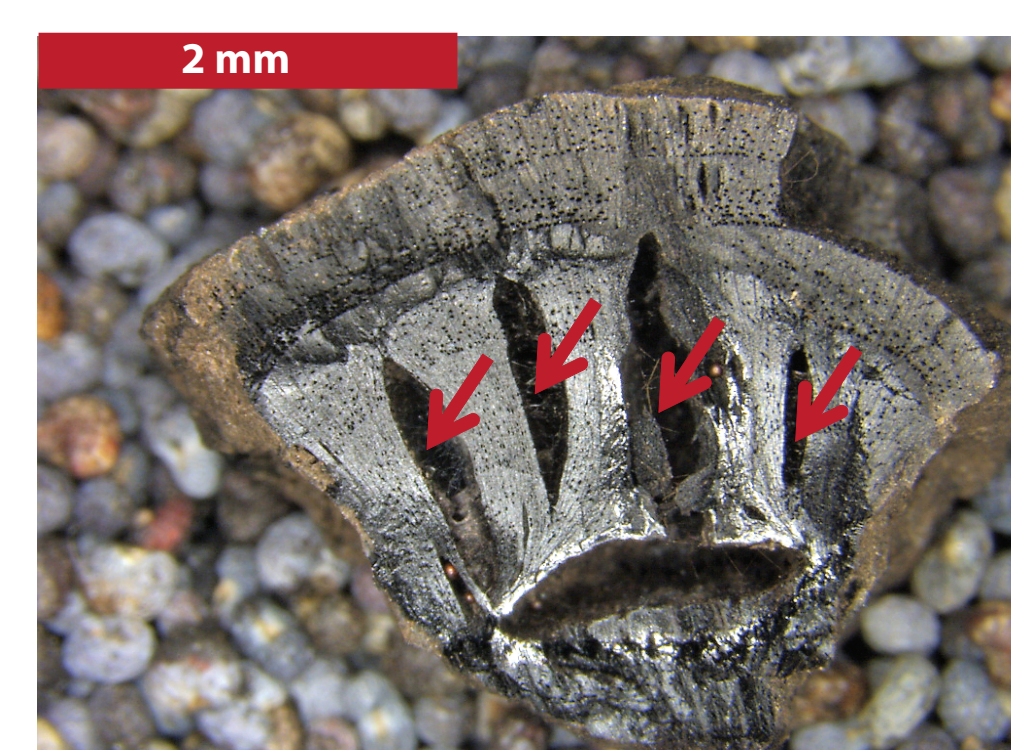


Fig. 5: Charcoal with radial cracks - *Fagus sylvatica* -

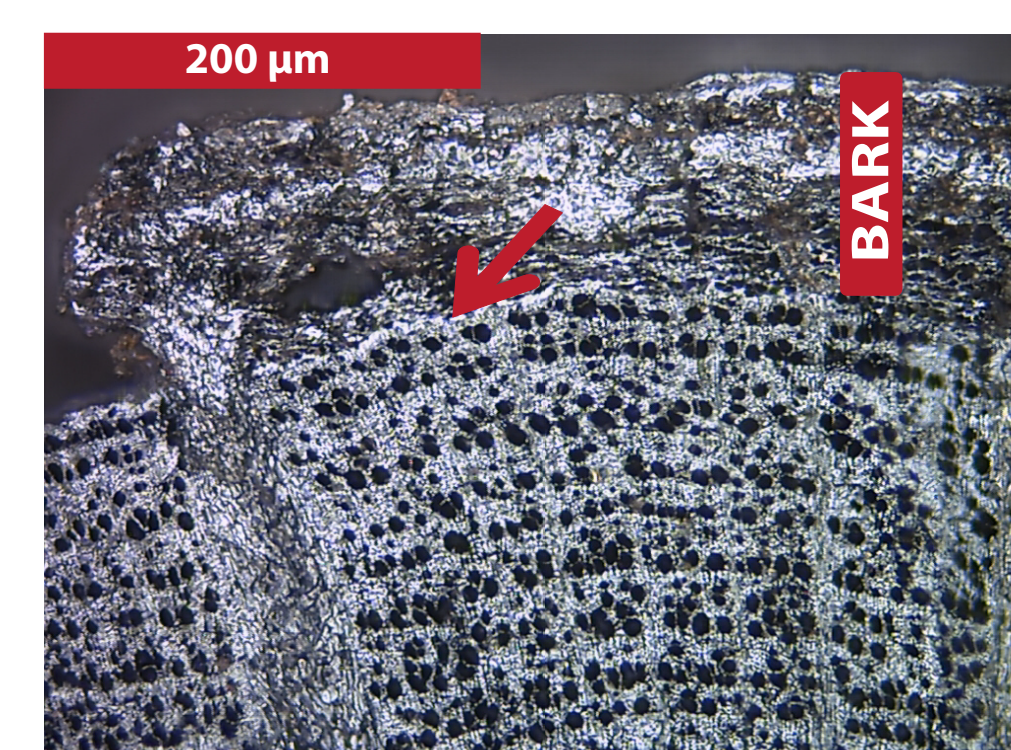


Fig. 6: Charcoal with bark - *Fagus sylvatica* - located into the final wood

Results

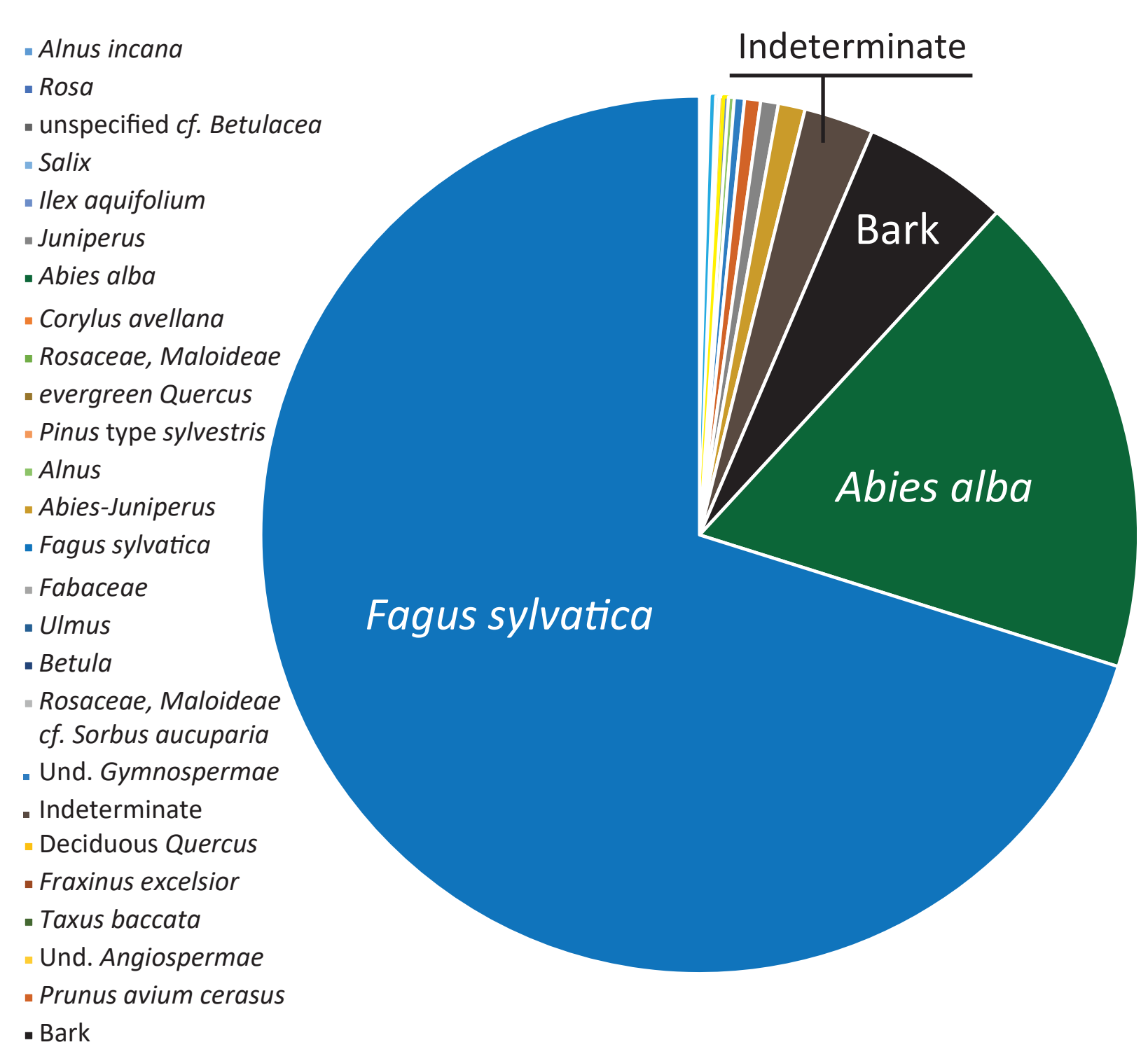


Fig. 7: Taxa proportions in %

7990 charcoals were analysed and 24 taxa were found. The corpus is largely dominated by *Fagus sylvatica* totalling 70.1% of the relative frequencies. The second taxon strongly represented is *Abies alba* with 17.9%. The other taxa have relative frequencies below 1%.

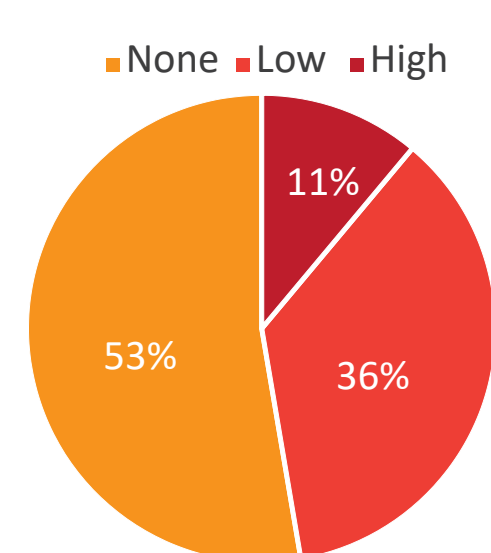


Fig. 8: Hyphae proportions

53% of the samples are healthy. There are hyphae in 47% of charcoals with low (36%) to very altered (11%) degrees of alteration. This indicates a phase of wood storage before charcoal making.

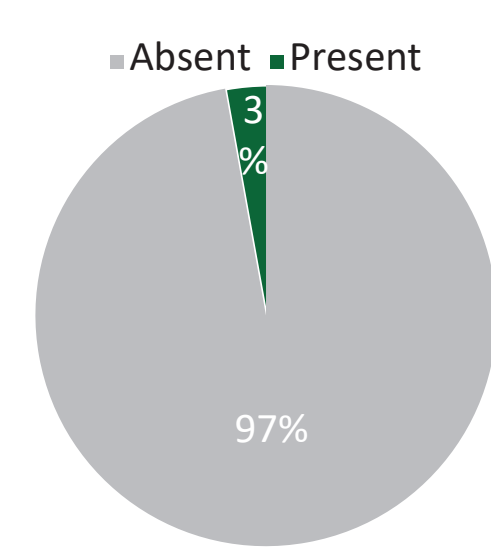


Fig. 9: Cellular collapse proportions

Only 3% of charcoal has cellular collapse. This indicates that the use of very degraded or rotten wood for charcoal production is very low.

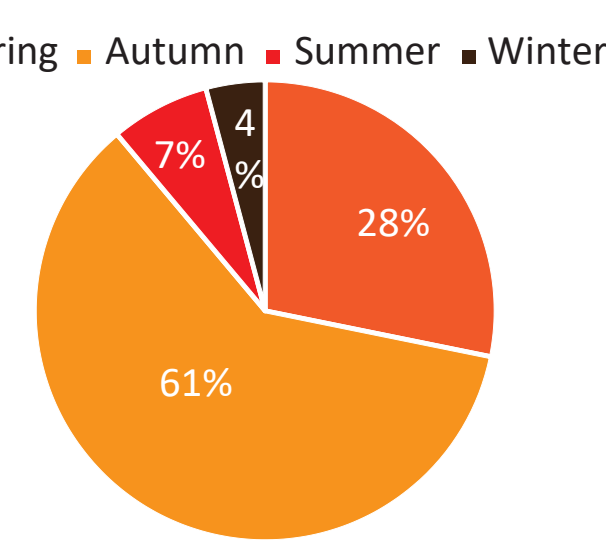


Fig.10: Logging seasons

8.2% of charcoals have preserved their bark. Their study shows that most wood harvesting is carried out between late summer, autumn and the off-season, i.e. winter.

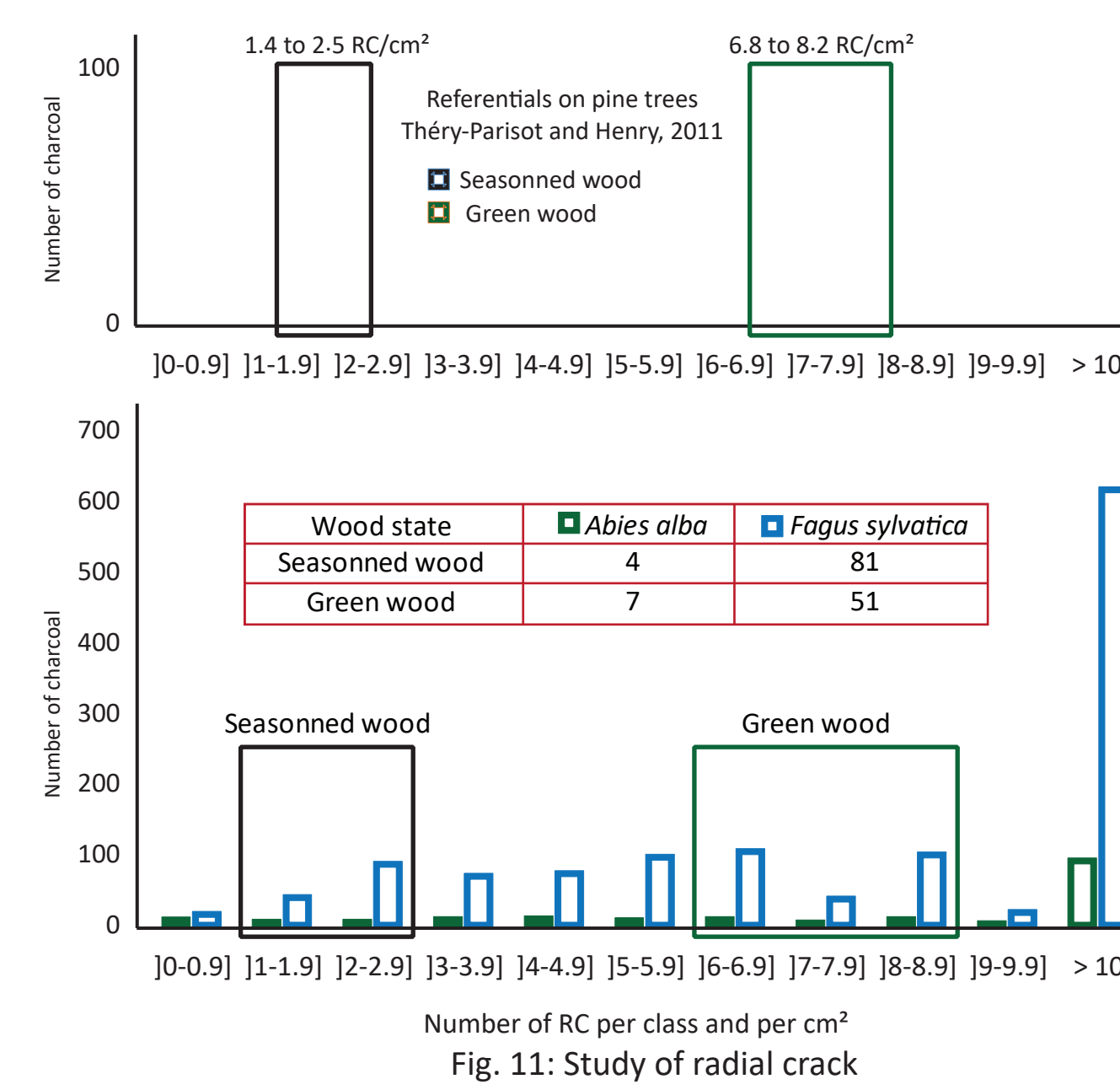


Fig. 11: Study of radial crack

Only 4 out of 150 charcoals for fir and 81 on 1523 for beech are in the established range for the characterisation of seasoned wood by Théry-Pariset and Henry (2011). These results do not allow an optimal interpretation of the data. However, they could indicate a combined use of dry and green wood by charcoal makers or use of moderately dry wood obtained after storage

Sources	Cutting season	Timber age at cutting	State of the wood at cutting	Storage and duration	State of the wood after storage	Carbonisation season
Percy, J., 1864	During the winter, when the wood is no more sap	Preferably 30 years old	Wood in maturity, neither too old or too young	A few months in the open air (duration not specified)	Moderately dry, better yield than wet or too dry wood. Rotten wood is not recommended	N/A
Du Monceau, D., 1761	At the time of the fall of the first leaves until April when the sap rises in the trees	Between 18 and 20 years old	N/A	From 4 months to 1 year	Moderately dry, Rotten wood is not recommended	Between september and october to supply forges and from July for private individuals

Fig. 12: Synthesis of historical data

Discussion and perspectives

Main phases of forest evolution

The anthracological data assembly shows a first episode of charcoal making activity during the year 1000. This practice intensified and became exclusive in the modern era. In the early Middle Ages, a beech-fir forest was established where beech dominated. The fir was gradually eliminated by charcoal making activity between the middle of the 15th and 17th centuries. An almost monospecific beech forest was then established between the middle of the 17th and 18th centuries (Fig. 13).

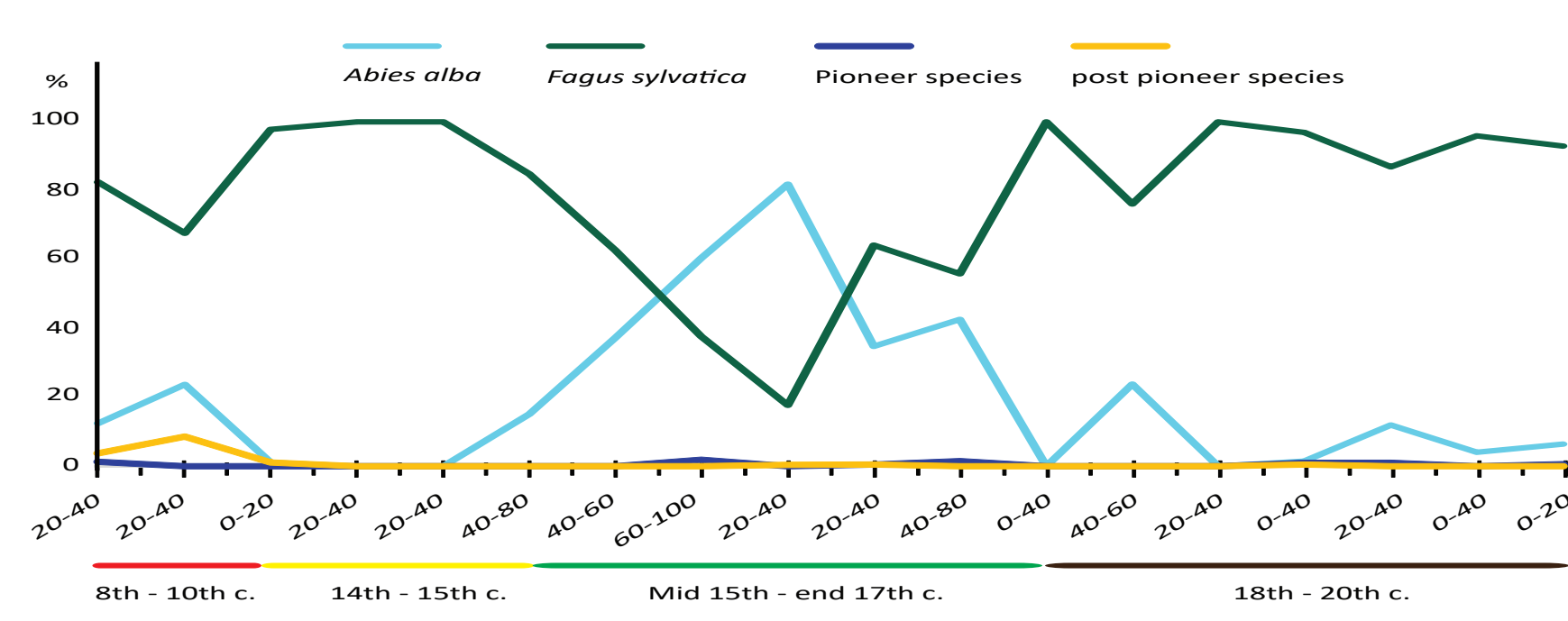


Fig. 13: Main phases of forest exploitation

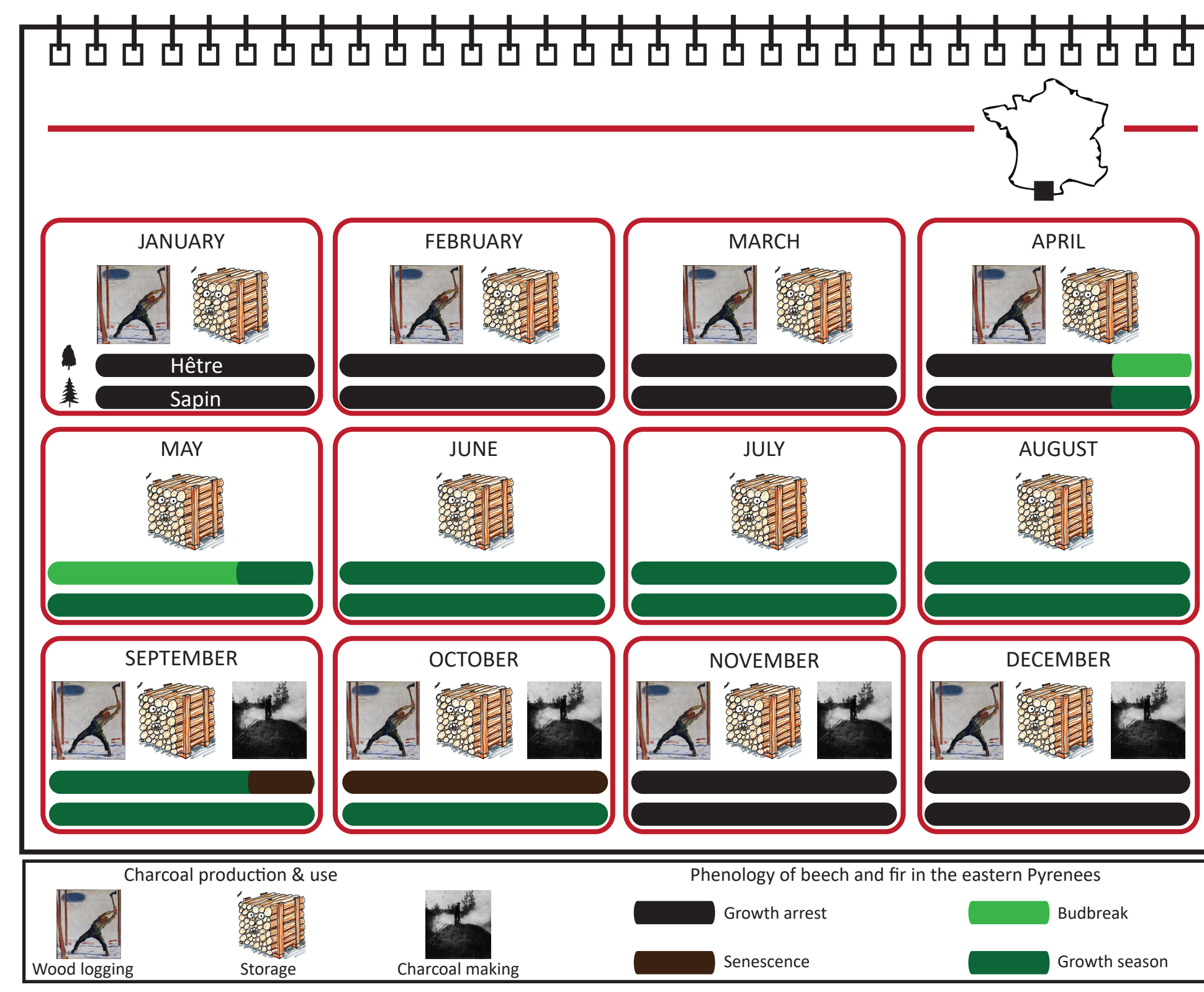


Fig. 14: Annual calendar of charcoal making activity

Technical operating chain of charcoal making

All of these results (study of bark, hyphae, collapse, radial cracks) give insight of the annual cycle of charcoal burning (Fig. 14). Wood harvesting is carried out from autumn and before the recovery of vegetative activity. Then, the felled wood remains were stored in the forest for several months. This storage period is long enough to cover the summer period, i.e. at least 6 months or more depending on the year. This allows to obtain partially dry wood that is better adapted to charcoal production. As indicated by historical sources, the rotten wood is rarely burn and it's recommended to use wood that is too not dry or too green for a better productivity (Fig.12). The charcoal making activity begins in the next spring after cutting and/or at the next autumn before the first snowfalls. Wood is rarely charred in winter.

Perspectives

- Refine the characterisation of charcoal practices through the current acquisition of experimental reference data on beech and fir.
- Combine with this approach, the dendrochronological study of charcoal kilns to reconstruct technical operating chain of charcoal making activity at high temporal resolution.

(i) Du Monceau, D., 1761. Art du charbonnier, ou Manière de faire le charbon de bois, par M. Duhamel Du Monceau. - Additions et corrections relatives à l'art du charbonnier, par M. Duhamel Du Monceau. Source gallica-bnf.fr / Bibliothèque nationale de France. 69 p.

(ii) Percy, J., 1864. Traité complet de métallurgie. Paris et Liège: Librairie polytechnique de Noblet et Baudry. Tome premier- 556p.

(iii) Py-Saragaglia, V., Saulnier, M., Cunill Artigas, R., Fouédjeu Fomou, L., Paradis-Grenouillet, S., Buscaino, S., Chapter 10. "Long-term Forest Evolution and Woodland Uses in an Ancient Charcoal-production Forest of the French Eastern Pyrenees: an Interdisciplinary Approach with High Spatio-temporal Resolution" dans Paradis-Grenouillet Sandrine, Aspe Chantal et Burri Sylvain (eds), Into the Woods: Overlapping perspectives on the history of ancient forests, Versailles, éditions Quae, e-pub in open access, 2018. <https://www.quae.com/product/1539/9782759229079/into-the-woods>

(iv) Théry-Pariset, I., Henry, A., 2011. Seasoned or green? Radial cracks analysis as a method for identifying the use of green wood as fuel in archaeological charcoal, Journal of Archaeological Science (2011), doi:10.1016/j.jas.2011.09.024.