Report to SAHRA regarding the analysis of charcoal from the Later Stone Age deposits of Bushman Rock Shelter (Limpopo Province, South Africa)

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This material is analysed in the context of the PhD project of Elysandre Puech, co-supervised by Isabelle Théry-Parisot and Marion Bamford. Below, a progress report on the PhD project is presented, which includes the material that was exported to the CEPAM, Nice. This material is currently still in France and will be repatriated to the Evolutionary Studies Institute, University of the Witwatersrand, at the beginning of 2023.

PhD title: "Analysis of archaeological charcoals from the Later Stone Age layers of Bushman Rock Shelter, South Africa: palaeoenvironmental reconstructions and implications for hunter-gatherer behaviours at the Pleistocene/Holocene transition."

PhD progress report

Subsampling protocol: representativeness and estimation of diversity and taxonomic fragmentation

A mathematical function correlating the weight to the number of fragments preserved allowed us to estimate the number of charcoal fragments distributed over a selection of 267 excavated *décapages* with surface measuring 40 cm x 50 cm and more than 1 m thick, where 26 stratigraphic units were identified. Given this particularly high number of preserved charcoals, a sub-sampling protocol was established to adapt to the conservation characteristics of southern Africa and to meet the research objectives. To initiate this process, a literature review was conducted to establish a list of previous anthracological studies conducted in the southern African region and is regularly updated . In addition, a detailed survey of the different published methods of charcoal studies was also listed according to: geographical origin, age of deposition, associated cultural period, abundance, preservation *etc*. The need to propose a reproducible method for each unit but also transposable to other sites to assess whether the taxonomic richness and fragmentation of the sample analysed adequately reflects those of the total assemblage was highlighted. For the first time implemented in an anthracological study in the region, this protocol aims to evaluate the representativity of the sample analysed regarding the total assemblage, making it possible to obtain a reasonable sample size and statistically significant.

Two stratigraphic units were chosen as "test" to assess the relevance of the method to adopt for the whole sequence. These units were identified as so-called "synthetic" layers, resulting from a depositional process accumulated over a long period, hardly attributable to specific activities. Charcoal fragments contained in these units were sorted, weighed and counted by size class. Size class, diversity, spatiality and interspecific fragmentation were discussed. Thus, the results of this study recommend analysing Bushman Rock Shelter charcoals according to 3 size classes < 5 mm, [5; 10 [mm and ≥ 10 mm to observe differential fragmentation of taxa. Resolution to the stratigraphic unit is appropriate to address changes in woody vegetation within the stratigraphy. Finally, it is proposed to present the saturation curves in logarithmic scale for a better visualization of the representativeness of the specific richness in the studied layer. The results of this study were presented at the 7th International Anthracology Meeting in Liverpool in September 2019 and then published in 2021 in the Special Issue Anthracology: Charcoal Science in Archaeology and Palaeoecology of the peer-reviewed journal Quaternary International.

Progression on both the wood anatomy and micrographs databases of wood and charcoal

The descriptions of the anatomical characteristics of the wood and charcoal from the various sources consulted during the PhD (fieldtrip, bibliography and xylotheques) are compiled in a single database unique for the region. These descriptions, which count more than a hundred anatomical characters by specimen, are regularly updated and adjusted. In particular, within the framework of the *Arch-AI-Story* project, an important work of homogenization of the data coming from different sources is carried out in order to be included in this base and exploited by the experts of applied mathematics of CEPAM for the taxonomic classification assisted by artificial intelligence.

Within the framework of the Working Group "Imaging" of the *GDR Sciences du bois*, all the images from the reference collection created for this thesis have been uploaded in the online database "*Anatom-IA*", *i.e.* 1567 micrographs acquired with a reflected light microscope and a scanning electron microscope. This wood anatomy image bank is collaborative and is dedicated to research and training as an interoperable tool for anatomical identification based on artificial intelligence. To feed this image bank, it was necessary to fill in the metadata of each image in an exhaustive way of each image (geographical origin, taxonomy, anatomical section, magnification microscope used, etc.), *i.e.* 31 fields to be filled in per image. Together, the anatomical database and the image bank will be integrated into a software dedicated to taxonomic classification (*e.g.* Xper2) to create the first digital identification key for the region. The next objective would be to publish this database in the international journal dedicated to wood anatomists, the IAWA journal.

Progress of the anthracological analysis

These two methodological aspects, which are essential to the realization of this thesis, allow me to advance in parallel the taxonomic identification of the charcoals with the optical microscope in the laboratory of CEPAM. Four stratigraphic units and five structures associated

with combustion activities have been analysed so far. This represents more than 2,500 identifiable fragments spread over some thirty anatomical "types" of individualized archaeological charcoal each corresponding to one or more taxa. These "types", currently being described and identified are mainly represented by : mimosoïdae (the large family of acacias), Asteraceae (*Brachylaena* sp. mainly), Anacardiaceae (marula and *Searsia* sp.) but also *Boscia* sp, *Olea europea sbsp africana*, or *Ziziphus* sp.. Descriptions of the archaeological charcoal "types" identified at the Bushman Rock Shelter site will be published in order to discuss and argue the proposed identifications with respect to the literature and collections available for the region. Already proposed in other regions of the continent in Cameroon and Congo, it will take a critical look at the process of a critical look at the identification process of charcoal in this region rich in woody species. The micrographic images of the charcoal "types" identified during the anthracological analysis of the Bushman Rock Shelter site will also be integrated into the *Anatom-IA* image bank and will serve as "test" data for validation of the taxonomic classification algorithm.

This methodological work will serve as the basis for interpreting the frequency spectra of species identified along the Bushman Rock Shelter sequence, which will be presented in a published synthesis of the evolution of woody vegetation and climate associated with the Pleistocene/Holocene transition around the site.

Missing results to finalise the PhD thesis

Far from the first objectives of the initial subject of the thesis, which consisted in application of standard anthracological methods, my research was naturally oriented towards methodological work, including the creation of databases specific to the woods of the region. For a complete anthracological study, the EBO layer representing the base of the Later Stone Age stratigraphic units preserved at the site is currently analysed (December 2022), alongside the five combustion features associated with this unit. The material will be couriered back to South Africa at the beginning of 2023.