The multipurpose date palm "tree": anatomical identification of modern palm stems and practical application in the archaeological site of Madâ'in Sâlih (Saudi Arabia)

Charlène Bouchaud[1], Romain Thomas[2] and Margareta Tengberg[3]

1 University of Paris 1 – UMR 7041 CNRS-University of Paris 1, Archéologies et Sciences de l'Antiquité – 21, allée de l'Université, 92000 Nanterre, France ; charlene.bouchaud@gmail.com
2 Muséum national d'Histoire naturelle – UMR 7207 MNHN-CNRS-UPMC, Centre de recherche sur la paléobiodiversité et les paléoenvironnements – 57, rue Cuvier 75005 Paris, France ; thomas@mnhn.fr
3 University of Paris 1 – UMR 7209 MNHN-CNRS-University of Paris 1, Archéozoologie et archéobotanique – 55, rue Buffon 75005 Paris, France ; margareta.tengberg@mnhn.fr

Summary: *Anatomical characterization of modern palms enables to identify various genera of palms and the different parts of these plants: stem, petiole, lamina and root. Practical application of this anatomical study is employed for the first time at the archaeological site of Madâ'in Sâlih (Saudi Arabia) where charred plants have been found in domestic contexts dating from at least the 2nd century BC until the 7th century AD. Date palm (*Phoenix dactylifera *L.) dominates the assemblage. More petiole remains than stem fragments are testified. Some date palm root and leave remains are also present. These results will be discussed in a large perspective including literary sources and ethnographic observations in order to underline the management of the palm grove and the various uses of the date palm during Antiquity.*

Key words: *Palm, stem, anatomy,* Phoenix dactylifera *L., archaeology. Madâ'in Sâlih*

INTRODUCTION

Since Prehistory the date palm (*Phoenix dactylifera* L.) has played an important role in the economies of the hot deserts of the Middle East. Cultivated for its numerous useful products (fruit for food and fodder; leaves for covering and basketry; fibres for ropes and "wood" for construction and fuel), the date palm also constitutes the main species of oasis agrosystems. Besides seeds, carbonized fragments of ground and vascular tissues are commonly found at archaeological sites in the Arabian Peninsula (Lombard and Tengberg, 2001). Until now they were identified taxonomically without considering if they came from the palm stem or from the woody leaf base (petiole). Yet, the differentiation is important in order to understand practices of date palm exploitation and management of date palm gardens in the past. In this paper we suggest a method for distinguishing between the different parts of the palms on the basis of morpho-anatomy. This method is applied to material from Madâ'in Sâlih (northwest Saudi Arabia) (Fig. 1) and is interpreted in terms of plant use and fuel economy.

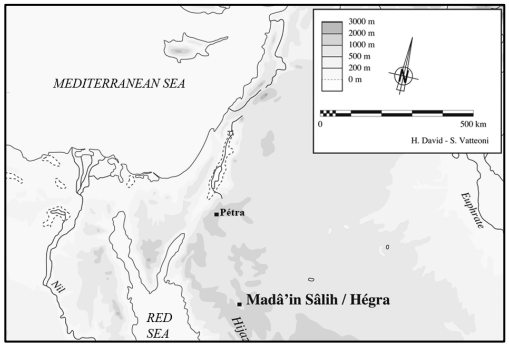

FIGURE 1. Location of the site (after H.David and S.Vatteoni)

ANATOMICAL STUDY OF MODERN SAMPLES

The main descriptors that discriminate palm petioles and stem are based on the fibrous vascular bundles (fvb) (Tomlinson, 1961). Those of the petiole (and thus of the leaf) are made of a well-developed ventral fibrous part (under xylem) and a dorsal fibrous part (above phloem) (Fig. 2D). At the level of the metaxylem, discontinuity between these two fibrous parts is always prominent. Those of the stem have a well-developed dorsal fibrous part. A ventral fibrous part could exist for some genera but is only made of few fibre cells or sclerenchymatous parenchyma cells and it is not as prominent as that of the petiole (as for *Phoenix* L.). Within the stem, discrimination between some genera is possible (Thomas, 2011; Thomas and De Franceschi, *submitted*). Only *Phoenix* and *Hyphaene* Gaertn. are endemic to northwest Saudi Arabia (Fig. 2) (Dransfield *et al*., 2008) with a possible presence of *Nannorrhops* H.Wendl. Fig. 1 A–C shows the differences between their stem fvb.

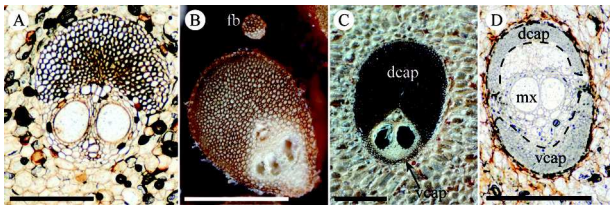

FIGURE 2. Transverse sections of Fibrous vascular bundles (fvb). ***A****. Stem fvb of* Hyphaene thebaica *without vcap and with a Reniforma dcap.* ***B****. Stem fvb of* Nannorrhops ritchieana *with Reniforma to Lunaria dcap and with an isolated fb.* ***C****. Stem fvb of* Phoenix dactylifera *with a Vaginata fibrous part (fibres cells all around the fvb).* ***D****. Petiole fvb of* P. dactylifera *with a small dcap and a well-developed vcap, these two fibrous caps are interrupted at the level of metaxylem (mx). Key to labeling: dcap: fibrous dorsal cap, fb: fibrous bundle, mx: metaxylem, vcap: fibrous ventral part. Scale bar: A–D: 500 µm.*

THE ARCHAEOLOGICAL DATA

The French-Saudi Arabian archaeological and restoration mission of Madâ'in Sâlih started in 2008, directed by Laïla Nehmé (CNRS), Daifallah al-Thali (Saudi Commission for Tourism and Antiquities) and François Villeneuve (University of Paris 1).

Madâ'in Sâlih, the antique site of *Hegra*, is located in a wide desert plain surrounded by mountains (Fig. 1). Arid conditions (± 50 mm of mean annual precipitation) are attenuated by mountain runoff that supplies subterranean groundwater. Today, the natural vegetation is composed mainly by open thorn scrublands.

The site was occupied at least between the 2nd century BC and the 7th century AD. Numerous rock-cut monuments underline various funeral and cultic areas. The excavation of the residential area located in the middle of the town has revealed dense domestic occupations. 1509.8 liters (145 samples) of sediment from fireplaces, refuses and destruction layers were processed by flotation. Palm fragments represent 30% to 50% of the total of wood observed per zone and period. Date palm fruit and seeds dominate the seed assemblages. Among the cultivated plants of the seed or wood corpus, others fruit trees (*Olea europaea* L., *Punica granatum* L., *Vitis vinifera* L.), annual crops (*Triticum aestivum*/*durum* L., *Hordeum vulgare* L., *Lens culinaris* Medik., *Medicago sativa* L.) and textile plants (*Gossypium* sp.) were also identified. Charred seeds and wood of wild plants as *Acacia* spp., *Tamarix* sp. and the *Chenopodiaceae* family are abundant (Bouchaud, 2010).

RESULTS AND DISCUSSION

The observation of specific anatomical criteria on the palm archaeological fragments allows distinguishing petioles, stems, *lamina* and roots. Petioles dominate the palm assemblages. Stem remains are abundant only in few contexts. Root and leaf fragments appear also but in less extend, maybe because of their fragility to fire. Only *P. dactylifera* species was identified among the archaeological stems.

We can assume that date palms were grown during all periods of occupation. This hypothesis is supported by archaeological survey that has revealed agricultural spaces outside the residential area irrigated from wells (Courbon, 2008). Date palm was probably the main crop, cultivated with others species mentioned above.

The dominance of petiole fragments may have resulted from the maintenance of palm groves, notably the pruning practices, as it is shown in ethnographic examples (Battesti, 2005) and classical literary sources (Theophrastus, 1842: II.6.4). Indeed, stems are less likely to be cut.

Use of the date palm as building material seems to be underlined in some destructions layers. Most of the archaeological contexts are fireplaces or refuse layers, which reveal the use of date palm as fuel. Although this is a common practice in oasis regions, however, little is known about it. Modern sources indicate that petioles are considered a good fuel (Munier, 1973), whereas Theophrastus maintains that the "tree" is not appropriate (Theophrastus, 1842: V.9.5) because of its smell.

Our results show that petioles are used for fuel purposes much more than stems. It is very difficult to say if their use as fuel is due to intrinsic properties (better consumption than stems?) or to their availability in nearest environments, as by-products resulting from agricultural management.

CONCLUSION

The present study attempts to underline the scientific potentiality offered by the anatomical characterization of modern palm stems and petioles and its practical application in the archaeological context. Well-defined archaeological layers compared with ethnographic and literary sources bring to light agricultural practices and fuel management.

REFERENCES

BATTESTI, V., 2005. *Jardins au désert: évolution des pratiques et savoirs oasiens: Jérid tunisien*. IRD éditions, Paris.

BOUCHAUD, C., 2010. Archaeobotanical report. In: Nehmé, L., Al-Thali, D., Villeneuve, F. (eds) *Report on the Third Excavation Season (2010) of the Madâ'in Sâlih Archaeological Project*, 233-252. http://halshs.archives-ouvertes.fr/halshs-00542793/fr/

COURBON, P., 2008. Les puits nabatéens de Madâ'in Sâlih (Arabie Saoudite). *Arabian Archaeology and Epigraphy* 19, 48-70.

DRANSFIELD, J., UHL, N., ASMUSSEN-LANGE, C. B., BAKER, W. J., HARLEY, M. M., LEWIS, C. E., 2008. *Genera Palmarum: The Evolution and Classification of Palms*. Kew Publishing, Kew.

LOMBARD, P., TENGBERG, M., 2001. Environnement et économie végétale à Qal'at al-Bahreïn aux périodes Dilmoun et Tylos. Premiers éléments d'archéobotanique. *Paléorient* 27, 167-181.

MUNIER, P., 1973. *Le palmier-dattier*. Maisonneuve & Larose, Paris.

THEOPHRASTUS, F.W., 1842. *Historia Plantarum*.

THOMAS, R., 2011. Palm-ID, a database to identify the palm stem anatomy with an expert system (Xper^2). http://www.infosyslab.fr/Palm- ID/

TOMLINSON, P.B., 1961. Palmae. In: Metcalfe, C. (Ed.) *Anatomy of the Monocotyledons*. Oxford University Press, Oxford.