Domestication of date palms in Siwa oasis and across the Middle East and North Africa : articulate the scales of ethnography and domestication over the long term

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Domestication of date palms in Siwa Oasis and across the Middle East and North Africa: Articulating the scales of ethnography and of domestication over the long term

Data : under publication (Gros-Balthazard & Battesti *et al.*)

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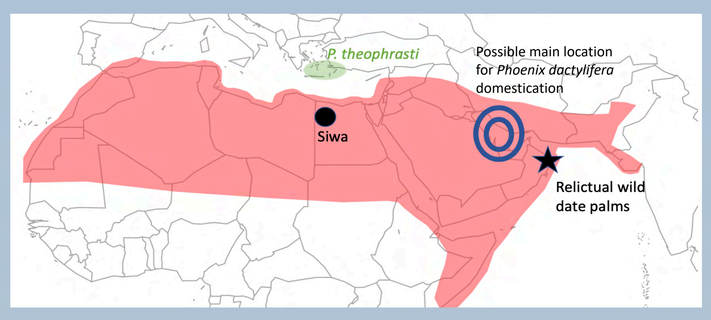
Studying date palm agrobiodiversity in the oasis of Siwa (Egypt), by combining ethnobotany and genetics, we demonstrated:

- The existence of "ethnovarieties," i.e., voluntary collections of multiple clones sharing mostly phenotypic characteristics under the same local name, as a way to manage agrobiodiversity.
- Siwa's cultivated date palms form a third genetic cluster, with a large and unique diversity, compared to the previously described Middle Eastern and North African date palms.
- Siwa region's feral date palms are also distinct, sharing alleles with another *Phoenix* species (*P. theophrasti*), a gene pool for local farmers.



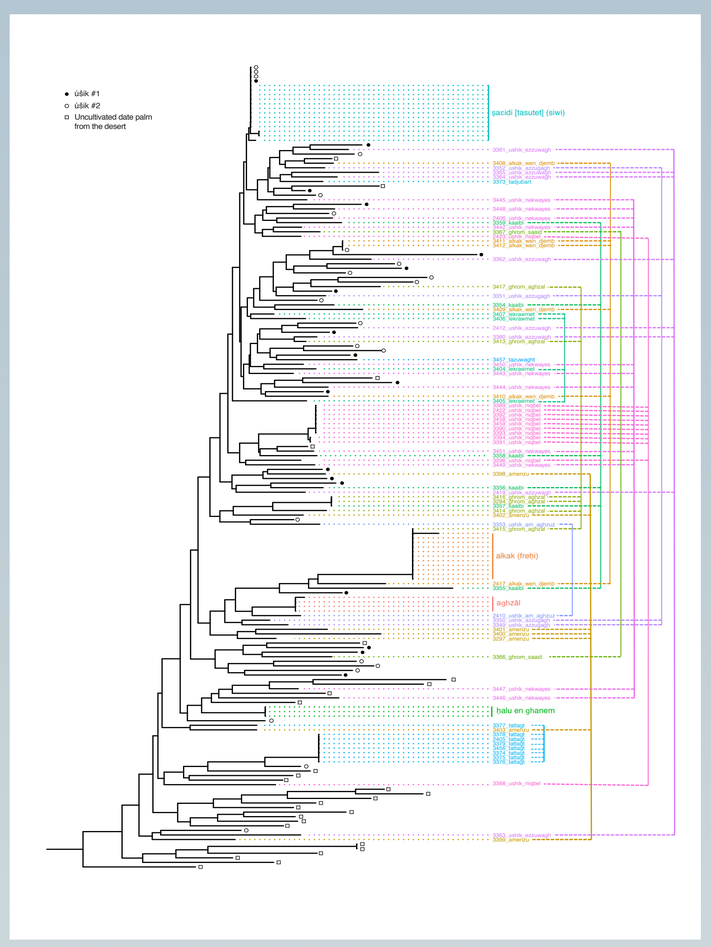
Siwa oasis (Egypt), at the crossroads of ancient Trans-Saharan routes and of the oriental and western genetic cluster

INTRODUCTION

The history of the date palm (*Phoenix dactylifera* L.) as a cultivated plant is still poorly known, despite some major advances made using genetic tools[1]. An unexpectedly high differentiation between African and Middle Eastern populations was discovered and its origins was only recently explained by the North African date palms being introgressed by a wild relative: *Phoenix theophrasti* Greuter[2].
Moreover, ways of assessing the current agrobiodiversity of the cultivated date palm do not yet seem well established[4].

OBJECTIVES: To better seize the long- and short-term domestication process of this cultivated and emblematic crop, the date palm, our approach combines anthropology (ethnoecology) with population genetics (using 17 microsatellite markers).

An original folk categorization system by Siwa inhabitants



Some named types are true cultivars as supposed to be in oasis phoeniculture: they share not only a formal identity, important for Isiwan people, but also a genetic identity.
Some are (what we coined) "ethnovarieties," i.e., voluntary collections of multiple clones sharing mostly phenotypic characteristics under the same local name.

The existence of "ethnovarieties" results from a cultural practice of oasis farmers towards date palm trees and from their way to think of them[3, 4].

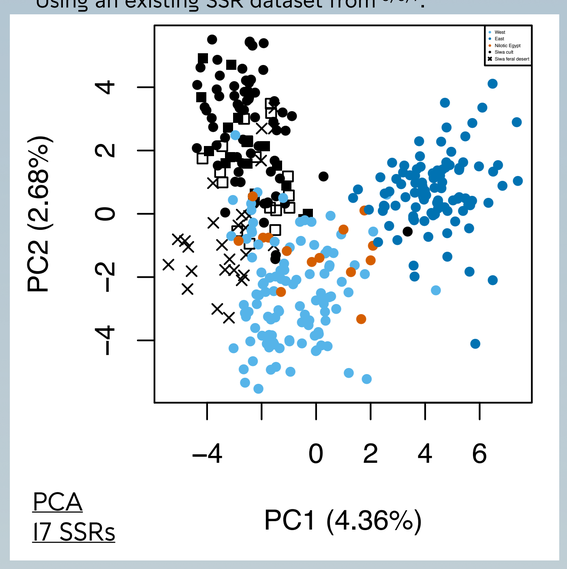
The same idea applies to the notion we call "categories", a way to name other date palms that are not or poorly reproduced by off-shoot by the local community.

The most direct consequence is the demonstration that we had until then a clear underestimation of the richness in genetic resources of date palm: about fifteen named types identified are not about fifteen genetic combinations of alleles.

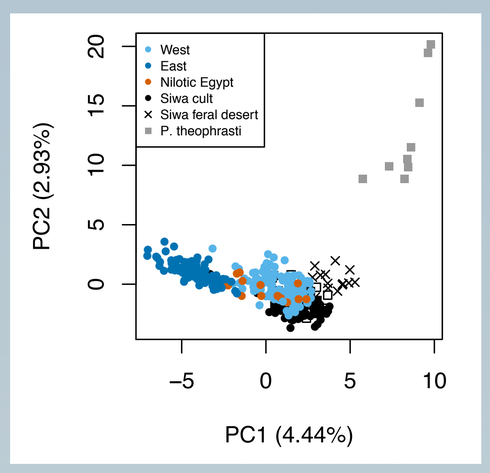
Why such a complex local system in Siwa for categorizing living organisms and in particular date palms?
- To stock a huge amount of information and to be able to mobilize it easily.
- To allow a flexible management of agrobiodiversity in this local context.

An original, large and unique biodiversity in Siwa

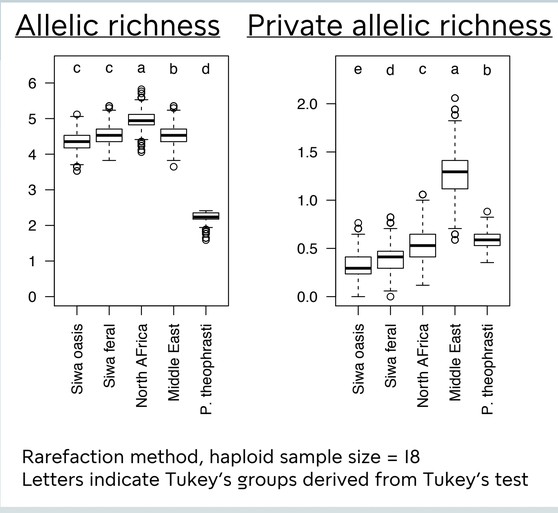
Using an existing SSR dataset from [5, 6, 7].



While we expected Siwa diversity to be found within the known African cluster, we found that it constitutes a separate population.



Feral date palms, collected in abandoned oasis around Siwa share alleles with *Phoenix theophrasti*, the species that is known to have introgressed African date palms[2].



Rarefaction method, haploid sample size = 18
Letters indicate Tukey's groups derived from Tukey's test

Siwa date palms show a very large diversity and a diversity that is unique to this oasis.

The origins of Siwa date palms is a mystery. Genomic data and our island theory of oases will further help us understanding this unique diversity.

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2 - Flowers, Jonathan M., et al. (2019), Cross-species hybridization and the origin of North African date palms. *PNAS*, 116 (5), p. 1651-1658. https://www.pnas.org/content/116/5/1651
3 - Battesti, Vincent & Gros-Balthazard, Muriel et al. (2018), Date palm agrobiodiversity (*Phoenix dactylifera* L.) in Siwa oasis, Egypt : combining ethnography, morphometry, and genetics. *Human Ecology*, 46 (4), p. 529-546. https://hal.archives-ouvertes.fr/hal-01716788
4 - Battesti, Vincent (2013), L'agrobiodiversité du dattier (*Phoenix dactylifera* L.) dans l'oasis de Siwa (Égypte) : entre ce qui se dit, s'écrit et s'oublie ». *Revue d'ethnoécologie*, 4. http://dx.doi.org/10.4000/ethnoecologie.1538
5 - Zango, O. et al. (2017), Genetic diversity of Southeastern Nigerien date palms reveals a secondary structure within Western populations. *Tree Genet. Genomes* 13, 75. https://doi.org/10.1007/s11295-017-1150-z
6 - Zehdi-Azouzi, S. et al. (2015), Genetic structure of the date palm (*Phoenix dactylifera*) in the Old World reveals a strong differentiation between eastern and western populations. *Ann. Bot.* 116, 101-112. https://doi.org/10.1093/aob/mcv068
7 - Moussouni, Souhila et al. (2017), Diversity of Algerian oases date palm *(Phoenix dactylifera* L., *Arecaceae*): Heterozygote excess and cryptic structure suggest farmer management had a major impact on diversity. *PLOS ONE*, 12 (4), e0175232. https://doi.org/10.1371/journal.pone.0175232

With the decisive collaboration of the farmers of the Siwa Oasis (Egypt) who shared their practices and knowledge.

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