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# Mediterranean carob populations, native or naturalized?Aix\*Marseille<br/>universiteAix Marseille<br/>universiteAix Marseille<br/>universite

Assif Oumarhouz, Morocco.

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## INTRODUCTION

Carob (*Ceratonia siliqua* L.) is a well-known Mediterranenan tree which was probably domesticated contemporaneously to the first trees (eg. olive, fig) in the Middle-East. Since then, carbo has played a crucial role due to its edible fruits used for cattle forage and subsistance agriculture. Carob plants are able to grow on stressful rocky soils, increasing the socio-economic value of many dry lands.

Despite its economic importance, the origins and history of carob populations are still under debate.

#### HYPOTHESIS OF CAROB DOMESTICATION

Stronge range contraction

followed by potential

Arabian and/or

Middle-East refugia.

Middle-East domestication.

Two main dispersal

routes by humans.



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<sup>5</sup> Laboratoire d'Ecologie et Environnement. Faculté des Sciences Semlalia, Université Cadi Ayyad. Marrakech (Maroc)

<sup>6</sup> CIRAD, LSTM, Tropical & Mediterranean Symbioses Laboratory. TA A-82/J Campus International de Baillarguet 34398. Montpellier, Cedex 5 (France) Carob in natural habitat, Ojén, Andalousia, Spain.



# OBJECTIVE

Reconstructing the most probable origin of the Mediterranean distribution of carob by contrasting natural *versus* human-mediated expansion.

## MATERIALS AND METHODS

- Three cpDNA regions sequenced for 49 populations of *C. siliqua* and two of *C. oreothauma*. Haplotype newtork was based on coalescence model.

- Environment Niche Modeling (ENM) reconstruction using 1,000 presence points for present, Mid-Holocene, Last Inter-Glacial (LIG) and Last Glacial Maximum (LGM).

- Divergence time estimations using a relaxed-clock model.



# RESULTS

Three haplotypes were found within *C. siliqua* with a strong geographic structure. The western haplotype of *C. siliqua* showed the higher probability of ancestry. *C. oreothauma* haplotype is significantly different to those in its congener (Fig. 1).



Divergence time estimations determined that the split between *C. oreothauma* and *C. siliqua* was 9.0 (17.6-2.6) mya, and that among the two main phylogroups found within *C. siliqua* at 1.6 (5.0-0.01) mya. These results also support a natural distribution of carobs in the Mediterranean.

FIG. 1: Haplotype network based on 3 cpDNA markers.

Current climatic niche conditions have determined the distribution of carob at present (Figs. 2, 3) and its history throughout climatic oscillations (Fig. 3). Carob shows a high sensivity to frost, with a cold limit in winter at 4.6 °C and an optimal at 10 °C (Fig. 2). FIG. 2. Niche modeling:minimum temperature of carob.Mean=10,3°C

ENM-based potential distributions (Fig. 3) showed that climatic conditions would have allowed the expansion of carob throughout the Mediterranean since LGM to Mid-Holocene times, preceeding the putative dispersal hypothesis by humans.



### CONCLUSIONS

Our results supports a natural Mediterranean distribution of carob before the emergence of agriculture. Multiple origins of domestication from native populations would explain the genetic structure.

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