Incorporating phylogeography for modelling the distribution of the carob tree (Ceratonia siliqua, Leguminosae) in future climate change
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To cite this version:
Alex Baumel, Eleonora Potenza, Valentine Frelon, Juan Viruel, Gonzalo Nieto-Feliner, et al.. Incorporating phylogeography for modelling the distribution of the carob tree (Ceratonia siliqua, Leguminosae) in future climate change. Genetics to the rescue: Managing forests sustainably in a changing world. GENTREE final conference, Jan 2020, Avignon, France. hal-02460403
Incorporating phylogeography for modelling the distribution of the carob tree (Ceratonia siliqua, Leguminosae) in future climate change.

A range contraction in the Mediterranean is predicted for carob tree due to climate change. Overlap analysis of climatic niches as well as Maxent modelling indicate that incorporating phylogeography may improve carob distribution modelling and forecasting.

In contrast with forecast done at the species level, the analyses done at the genetic groups level support SM, and EM as the most likely persistent areas whereas the most affected would be SS.


The carob is an evergreen termophilous fruit tree widely harvested throughout the Mediterranean for food and forage since antiquity. Currently, the carob is found in cultivation in orchards or in association with other crops, and it has expanded towards industrial, agricultural and soil restoration purposes. Wild populations are found in shrublands, forests as well as rocky outcrops and temporary river banks.

Two distinctive lineages diverged after a strong historical bottleneck, which subsequently split in four genetic clusters across the Mediterranean (SM, South Morocco; SS, South Spain; CM, Central Mediterranean; EM, East Mediterranean). Admixture is frequent due to human dissemination, such as in the North Moroccan populations (NM) which show asymmetric introgression between Eastern and Western genetic clusters.

Analysis of the overlap between current and future (2070) climatic envelopes

Data for the future were obtained by averaging the result of 3 GCM models (CNRM-CM5, HadGEM2-ES, CCSM4). Green, orange and red points correspond to the current period and to the RCP scenarios 4.5 and 8.5 respectively. A principal component analysis was done and used for a between class analysis (BCA) with the climatic change scenarios as factor. The first axis (BCA_1) corresponding to temperature is the most correlated to climate change forecasting.

Box plots of the distribution on BCA_1 axis of the five genetic clusters

New forecasting done with Maxent in respect to phylogeography and averaging results of 3 GCMs for RCP 4.5

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