

# Genomic structure and diversity of *Quercus suber* across its complete latitudinal distribution

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## INTRODUCTION

Drought conditions caused by climate change pose a threat to many plant species across the world. This global trend is prompting scientists to look at the potential involvement of local adaptations through intraspecific differences in functional traits, which could improve conservation methods by increasing plant resilience to the decreasing availability of water.

## OBJECTIVE

This study aimed to characterize the genetic diversity of natural populations of cork oak (*Quercus suber* L.) and to compare genomic patterns across populations in a latitudinal transect covering the complete latitudinal distribution of the species.

## METHODOLOGY

We have resequenced genomic DNA using the Illumina technology of a total of 101 individuals from seven populations of *Q. suber* ranging from Arnego, Galicia (northwest of Spain) to Los Alcornocales Natural Park (southwest of Spain) to evaluate the genetic structure of the transect as well as the genetic diversity of every population. The reads were aligned to a reference genome of the same species (GCA\_002906115.5). After filtering the SNPs for quality, linkage disequilibrium and missing data (obtaining a total of 6.957 whole genome SNPs), we estimated the population genetic structure using the tess3r R package and performed a Principal Component Analysis (PCA) using the ade4 package. Outlier loci were obtained using the Benjamini-Hochberg algorithm and their respective allele frequencies were calculated for each population.

## References

Caye, K., Deist, T. M., Martins, H., Michel, O., & François, O. (2016). TESS3: fast inference of spatial population structure and genome scans for selection. *Molecular Ecology Resources*, 16(2), 540-548.

Matías, L., Pérez-Ramos, I. M., & Gómez-Aparicio, L. (2019). Are northern-edge populations of cork oak more sensitive to drought than those of the southern edge?. *Environmental and Experimental Botany*, 163, 78-85.

Morillas, L., Leiva, M. J., Pérez-Ramos, I. M., Cambrollé, J., & Matías, L. (2023). Latitudinal variation in the functional response of *Quercus suber* seedlings to extreme drought. *Science of The Total Environment*, 887, 164122.

# R E S U L T S

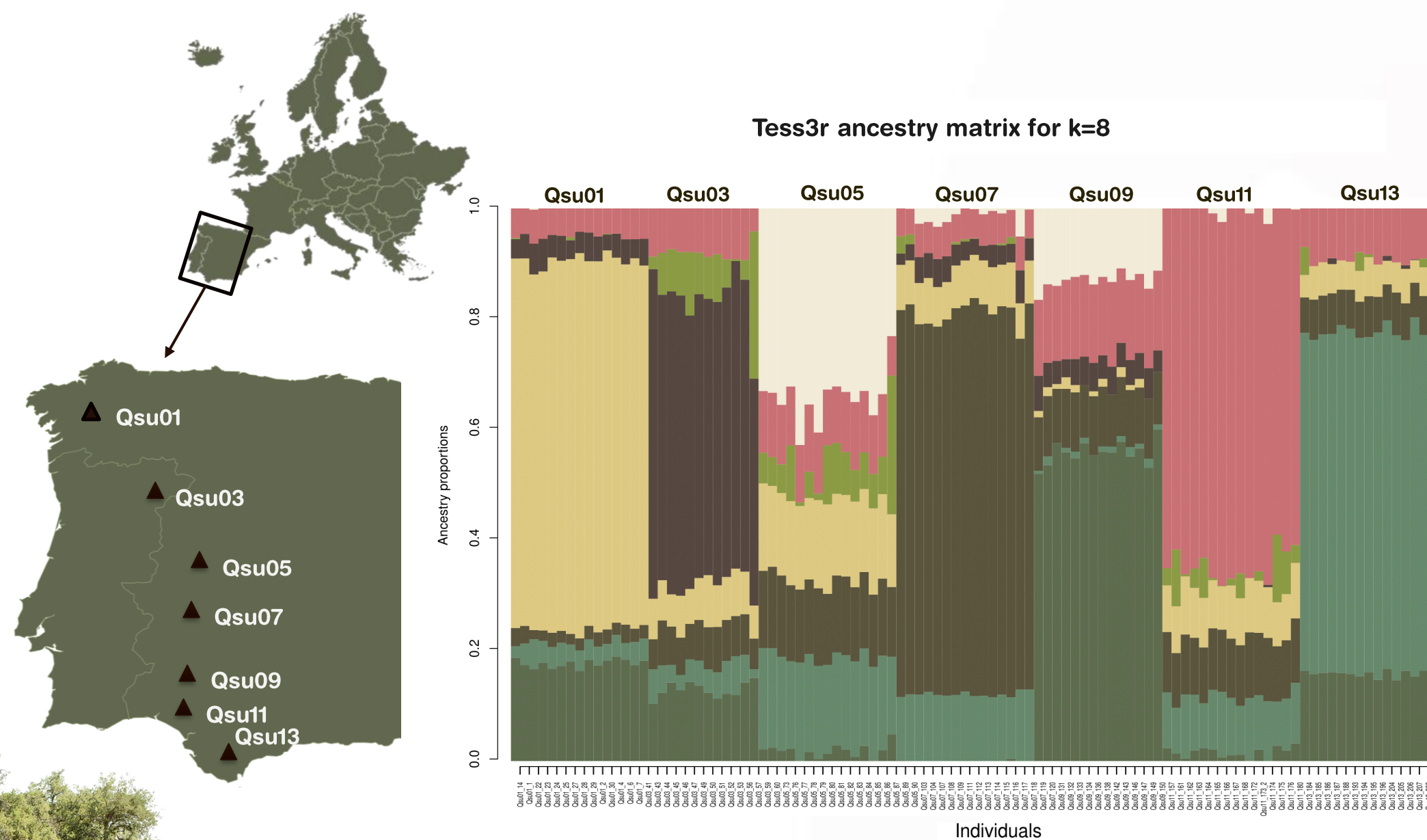


Figure 2: Tess3r results for best k (k=8) with ancestry matrix. The seven main clusters correspond to the studied populations (locations are shown in map).

## Principal Component Analysis

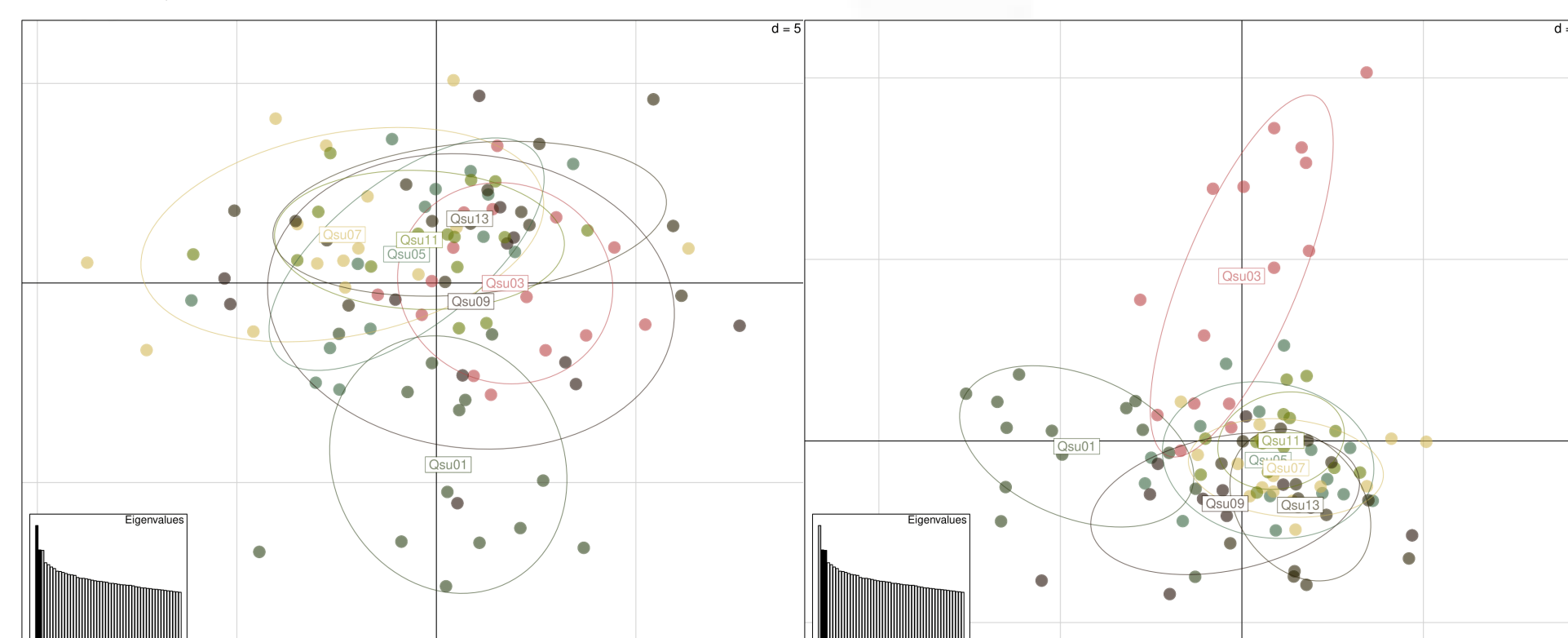


Figure 3: Principal components PC1 vs. PC2 and PC2 vs. PC3 for PCA analysis of whole genome SNPs. Each point represents an individual and the grouping of each population is outlined. The analysis shows a higher separation for populations Qsu01 and Qsu03, which are the two northernmost, while the remaining populations seem to be more related to each other.

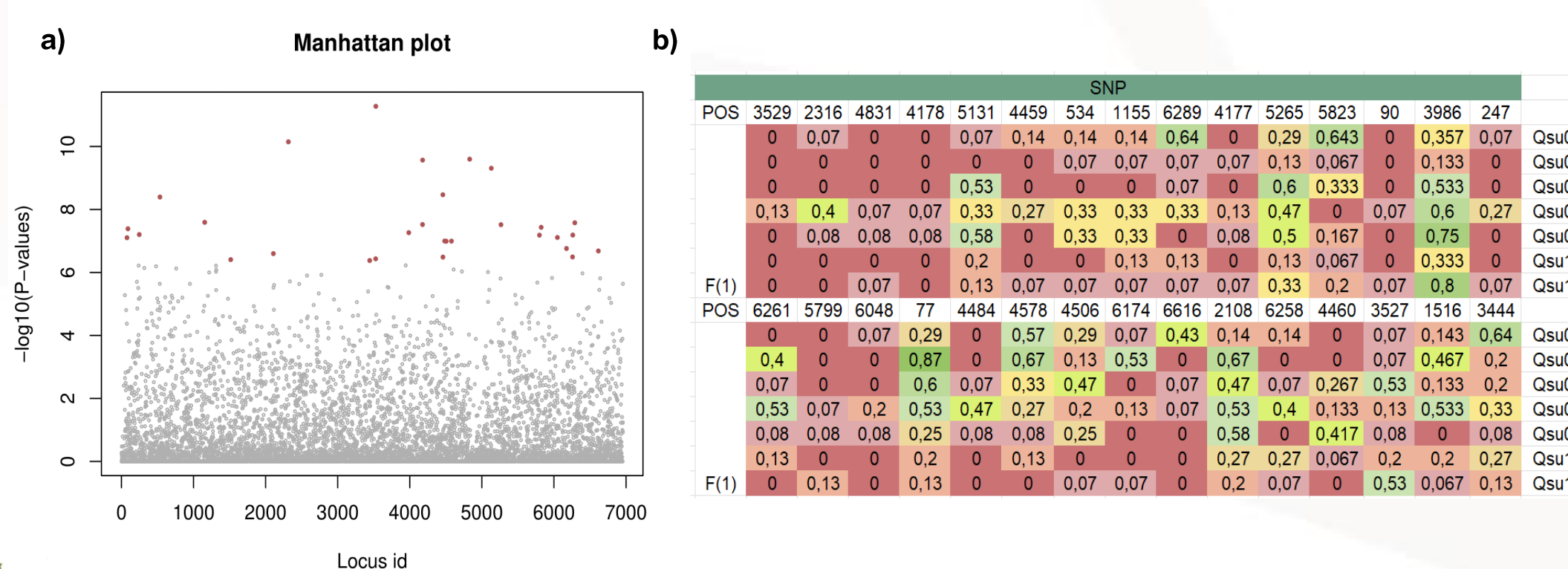


Figure 4: Identification of candidate SNPs that can potentially be correlated with drought resistance with a) Manhattan plot identifying 30 outlier loci (in red) from the genotypic matrix calculated with tess3r and b) allele frequencies of the 30 SNPs per population. Based on the projections of the ancestral allele frequency matrix, the algorithm calculates a population differentiation statistic that estimates a fixation index ( $F_{ST}$ ) for each locus (Caye et al., 2016). If local adaptation favors a certain allele in some ancestral populations, the population differentiation statistic at that locus will be higher.

## Discussion

We identified 30 outlier SNPs that are considered as loci potentially targeted by local adaptation, with seven being found in genes. Several of these SNPs have varying frequencies between populations. Therefore, we will conduct further studies to find potential candidates that are associated with the increased drought resilience in specific populations.



## CORK OAK (*Quercus suber* L.)

Cork oak is an economically and ecologically valuable woody species that is endemic to the Mediterranean region. For the last 80 years, the entire surface area of cork oak woodlands has been reduced from 140,000 ha to 70,000 ha. In recent years, there has been considerable research on the decline of *Q. suber* to understand how climate change impacts the distribution and viability of cork oak populations.

## Latitudinal Variation

Studies have shown that *Q. suber* populations exhibit latitudinal variation in their response to different environmental stressors, including drought, which is possibly attributed to adaptations to specific environmental conditions. This evidence suggests that certain populations may have developed genetic variants that enable resistance to drought conditions prevalent in their specific latitudinal range.

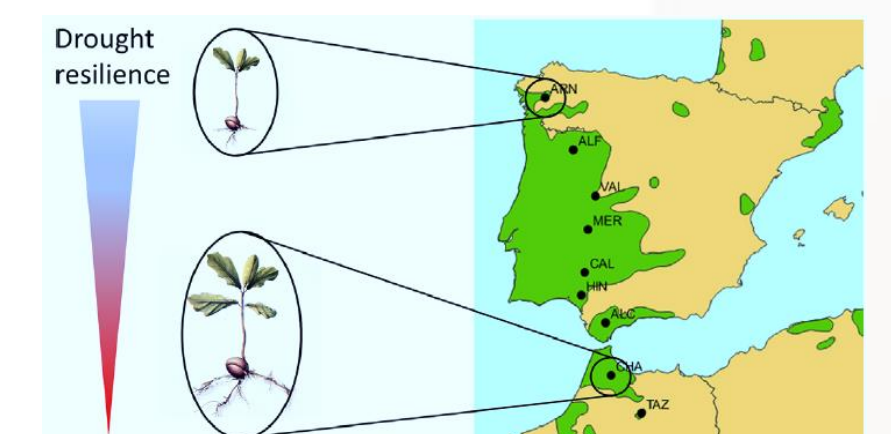


Figure 1: Distribution map of *Q. suber* showing its native range (green area) and the location of the source populations indicated by black dots. Southern latitude acorns produce larger seedlings than northern ones, although this leads to higher evaporative water loss, affecting their survival under extreme drought conditions (Morillas et al., 2023). Studies have shown that southern populations enhance features associated with belowground growth to increase water intake, allowing cork oak to function despite limited water availability, while high aerial biomass allocation hinders survival under drought stress (Matías et al., 2019; Morillas et al., 2023).

## CONCLUSION

Population structure analysis showed that there are seven main clusters which are genetically different, that correspond to the sampled populations. PCA results indicated that the northernmost populations are the most distinct. We have identified 30 SNPs that could potentially explain the variation in drought resistance across the studied populations. Further research will be done including Moroccan populations to explore the complete latitudinal range of *Q. suber*.

This research was funded by:



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