Convergent evolution in Mediterranean oaks

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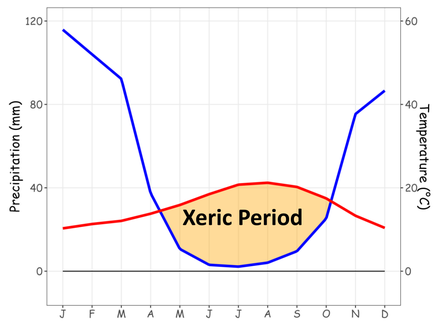
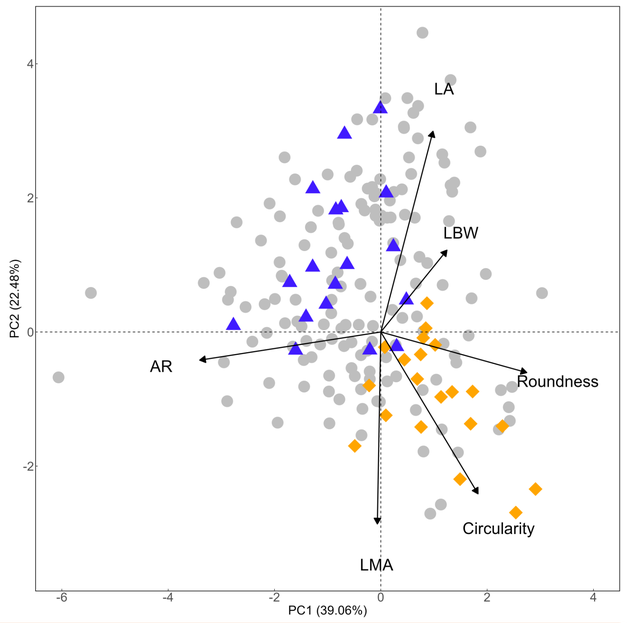
Introduction

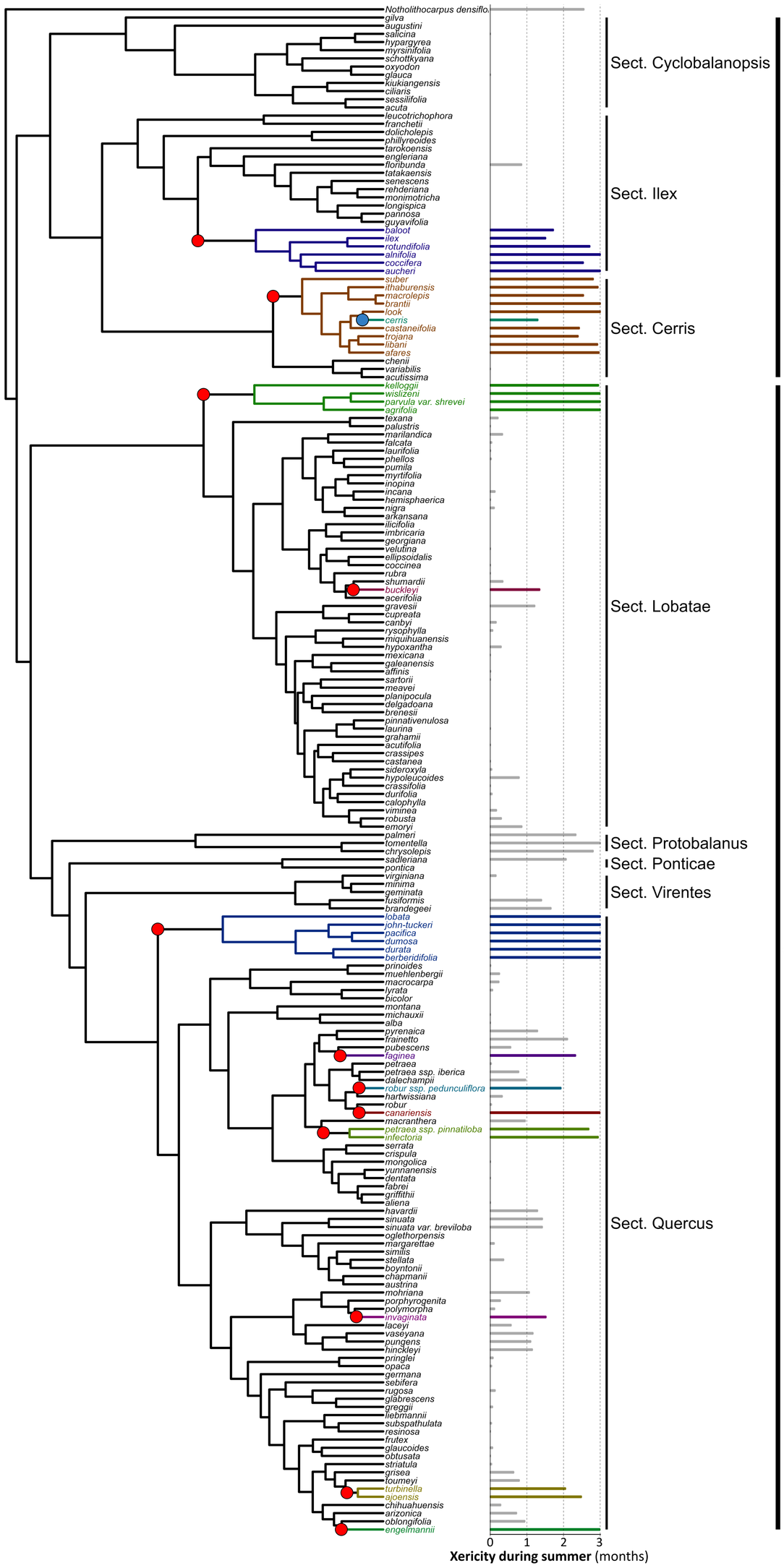
Oaks (genus *Quercus*) present ca. 400 species occupying a wide range of habitats around the Northern hemisphere. Around 30 spp. are present in the two Mediterranean regions: California and the Mediterranean Basin. These species belong to very different clades within the genus with different evolutionary histories.

The main characteristic of the Mediterranean climate is the presence of a xeric period during summer.. We will use this variable, ***Xericity during summer***, to identify Mediterranean species.



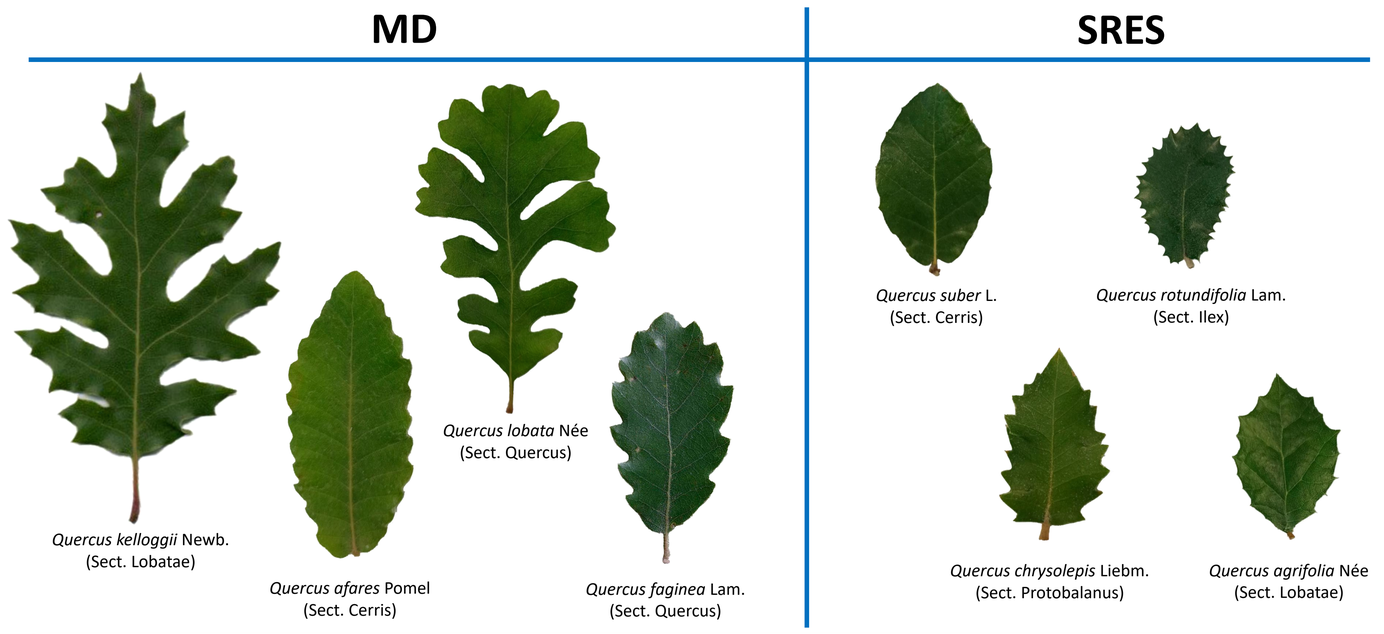


Material and methods: 187 oak species were sampled from Pouyouleix botanical garden (France). Several morphological traits were measured: leaf area (LA), leaf mass per area (LMA), circularity, roundness, aspect ratio (AR) and length from the base to the widest part of the lamina (LBW). A new phylogenetic tree was used for phylogenetic analysis: **PhylogeneticEM** to detect shifts in the xericity during summer (below) and **Phylogenetic PCA** (right). The algorithm k-means was used to verify if several groups can be found among species.



The Mediterranean climate induces two leaf syndromes

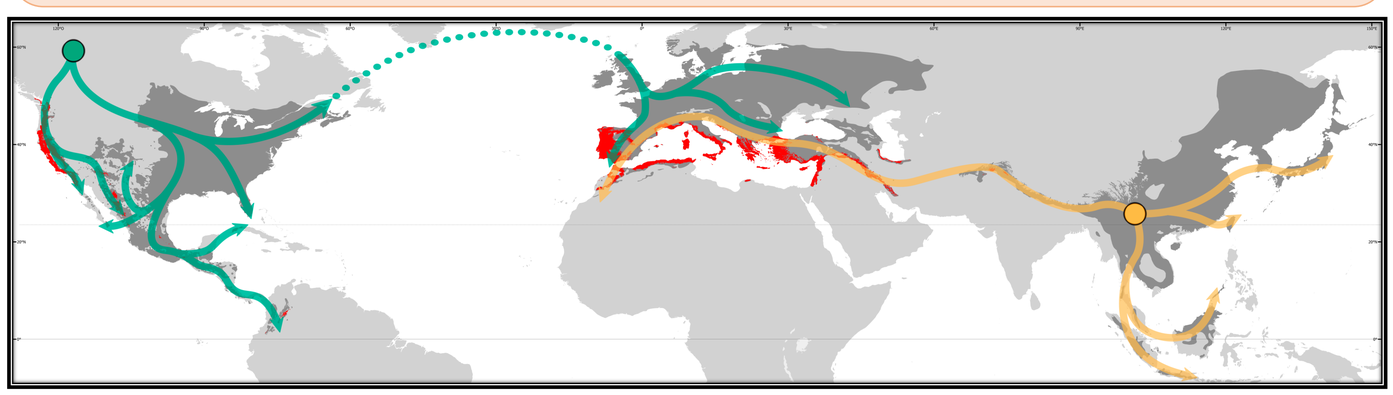
Phylogenetic PCA shows a wide variability of leaf morphology for Mediterranean species, covering almost all the variation in the genus (grey dots). The k-means algorithm recognizes **two groups:** one group composed by **small-rounded evergreen sclerophyllous species** (**SRES**, orange diamonds), which is more homogeneous than the **malacophyllous deciduous species** (**MD**, blue triangles). SRES species from different clades present a **convergent morphology**, but this leaf syndrome is not exclusive of Mediterranean clades since it is also present in several Mexican and sect. Ilex species.



Two origins. One Destiny

Old World oaks (subgenus *Cerris*) originated in **paleotropical** areas of Southeast Asia (orange circle) and then migrated to western Eurasia during Oligocene (orange arrows).

The origin of New World oaks (subgenus *Quercus*) is hypothesized to be **arctotertiary**, located in the northernmost part of North America (green circle). Then, species migrated south, colonizing California during the Oligocene, and Mesoamerica during the Miocene (green arrows). Roburoids clade has reached temperate areas of Europe and the Far East as well as the Mediterranean Basin, probably via North Atlantic Land Bridges (dotted green line).



The Mediterranean climate originated at different ages

The Mediterranean climate in the Mediterranean Basin emerged 2.6 Ma ago. Species from sections Ilex and Cerris had already been occupying the area for millions of years by then, under more humid conditions (subtropical). This suggest a **preadaptation** of Old World species to xeric conditions, which agrees with xeromorphic fossil records older than the Mediterranean climate.

In California, oak species seem to have evolved almost in parallel with the emergence of xeric conditions during summer in leeward slopes of the Rocky Mountains.

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