



Why do oaks (*Quercus* spp.) have lobed leaves?

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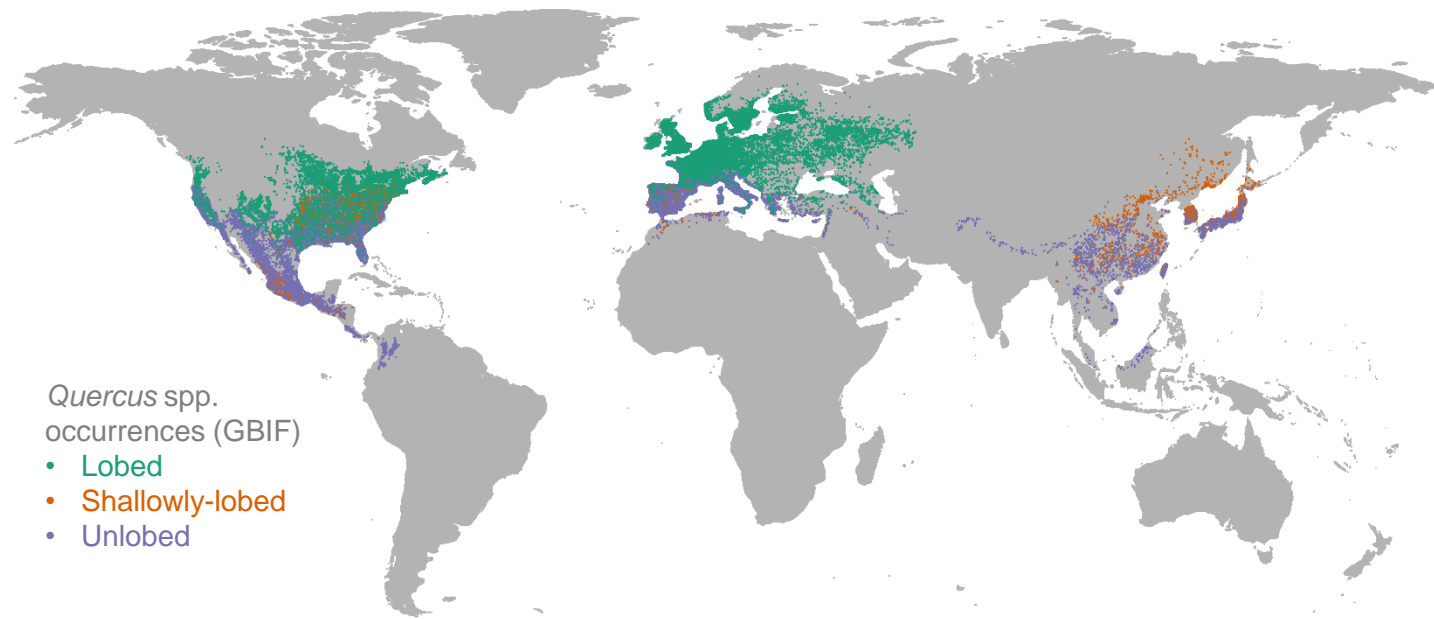


BACKGROUND & AIM

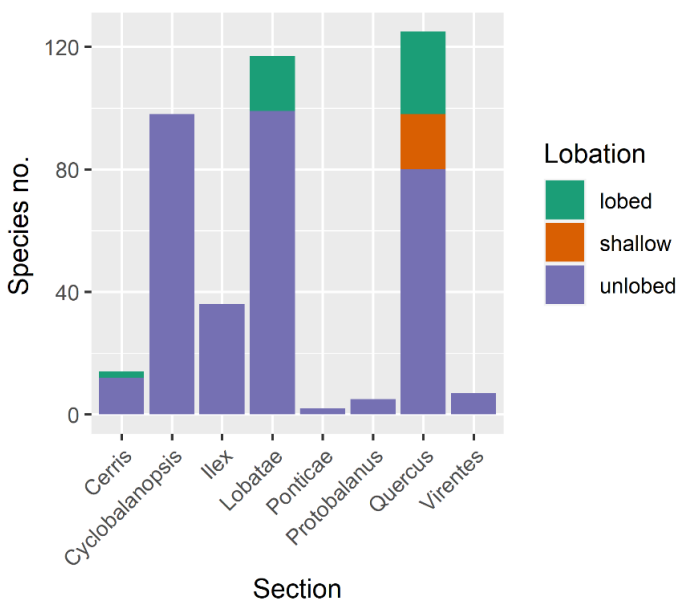
Lobed leaves are a characteristic feature of oak trees (*Quercus* L., Fagaceae) although only 10-15% of the ca. 400 species possess such leaves. We aim to assess:

- how lobed leaves are distributed across the global oak phylogeny;
- how their distribution is constrained by environmental variables (climate, soil properties); and
- trace their origin in the fossil record.

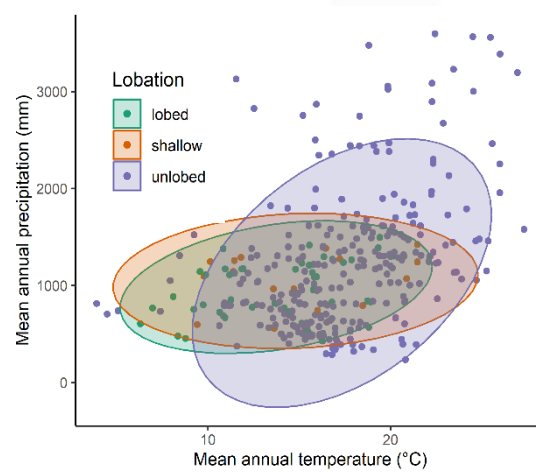
Distribution of lobation in modern species



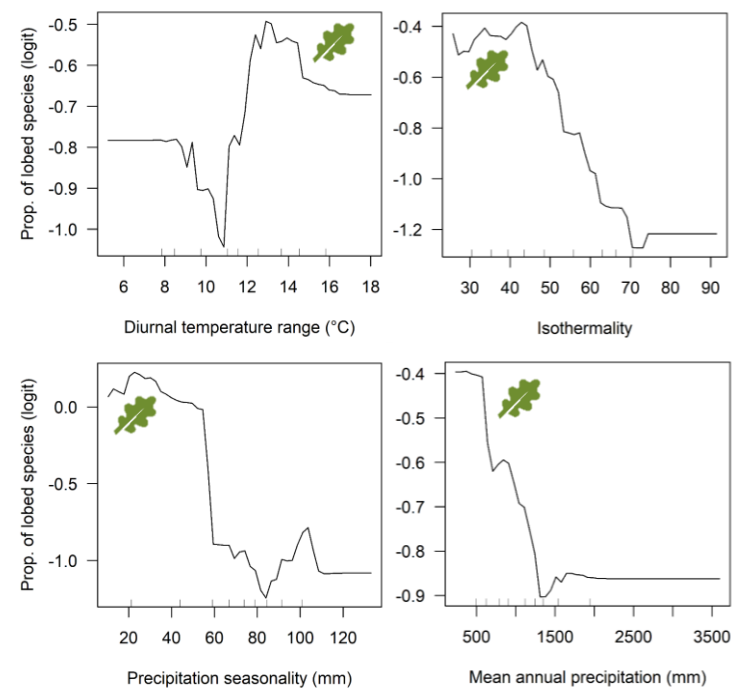
Distribution of lobation across phylogeny



Distribution of lobation across climate

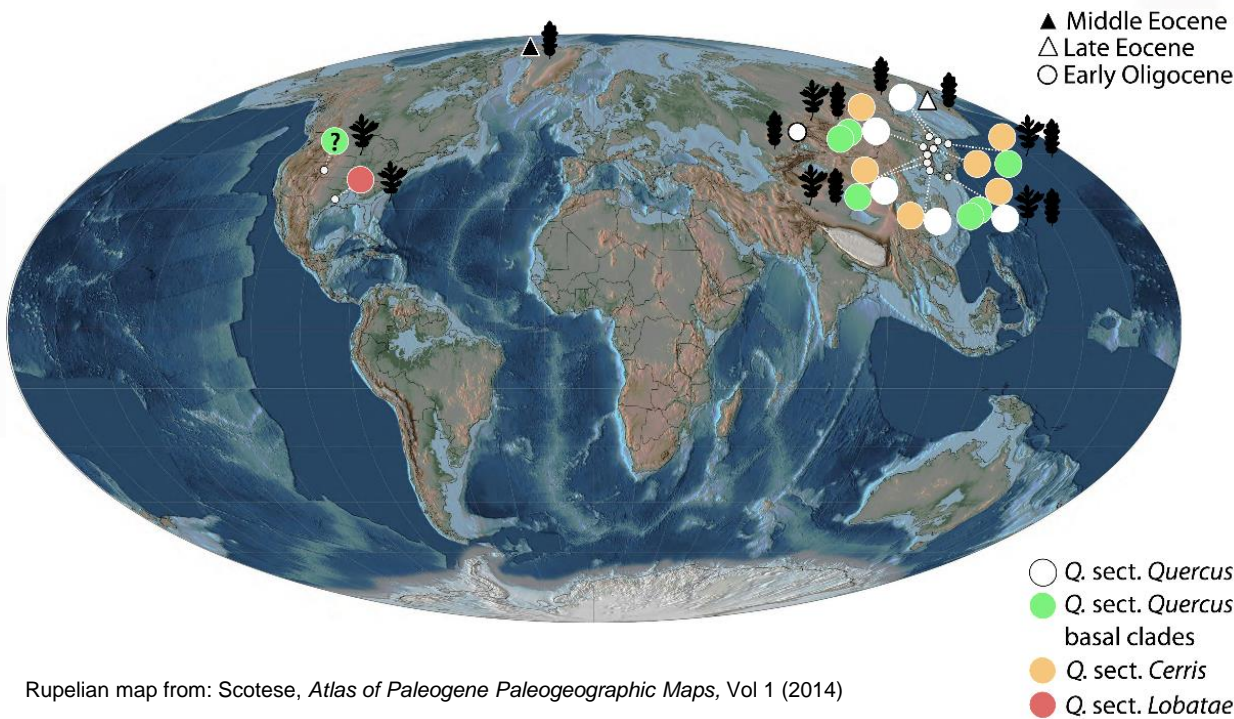


Climatic envelope of modern lobed, shallowly-lobed and unlobed oak species, based on GBIF occurrence data.



Partial Dependence Plots of four bioclimatic variables ranked by variable importance of the Random Forest model predicting lobation using environmental variables. The y-axis is in logit scale: higher on the axis reflects a higher proportion of lobed species.

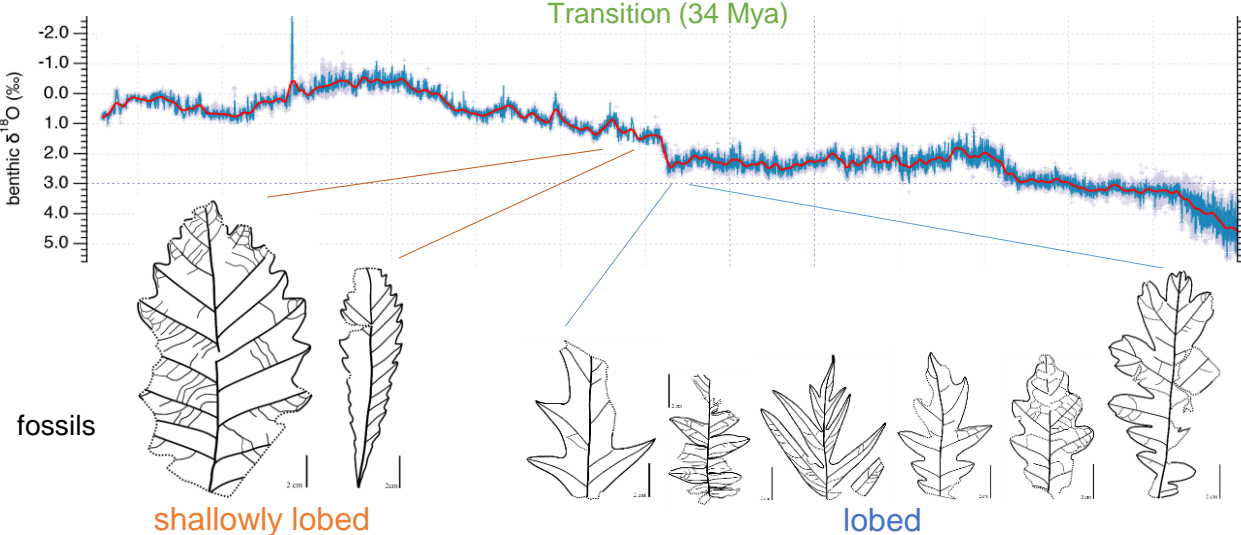
FOSSILS of (shallowly-) lobed oak leaves across space and time



Rupelian map from: Scotese, *Atlas of Paleogene Paleogeographic Maps*, Vol 1 (2014)

Epoch	Paleocene				Eocene				Oligocene		Miocene					Plioc.	Pleist.					
Stage	Maa	Dan	Sill	Tha	Ypr	Lut	Bar	Pri	Rup	Cha	Aqu	Bur	Lan	Ser	Tor	Mes	Zan	Pra	Pla	Col	Chil	Uel

Eocene-Oligocene Transition (34 Mya)



Cenozoic climate record from: Westerhold *et al.* *Science* 369, 1383-1387 (2020)

EVOLUTION AND ECOLOGY OF OAK LOBATION

Oaks became abundant in the northern hemisphere during the early Eocene (ca. 50 million years, myrs, ago) but the first records of deeply lobed leaves are only known from Oligocene deposits, at least 15 myrs later. Lobed leaves started to radiate in East Asia during the Eocene-Oligocene transition (EOT, ca. 34 myrs ago), where they later completely disappeared. The EOT denotes the most dramatic global drop in temperature during the past 65 million years.

The legacy of this radiation is still visible in the geographical distribution and climatic envelopes of modern species. Lobed species occur at higher latitudes and expand into colder areas in North-America and Europe, and are characterized by higher temperature ranges and lower precipitation and precipitation seasonality.