

# Into Mesoamerica: convergence of *Quercus* functional traits across environmental gradients

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**Introduction:** Oaks have sympatrically expanded into Mexico and Central America in the last 10 to 20 Ma (Hipp et al. 2018). We investigated whether parallel clades, primarily sections **Lobatae** (reds), **Quercus** (whites) & **Virentes** (live) converge on similar strategies of leaf and stem traits in response to broad environmental niche.

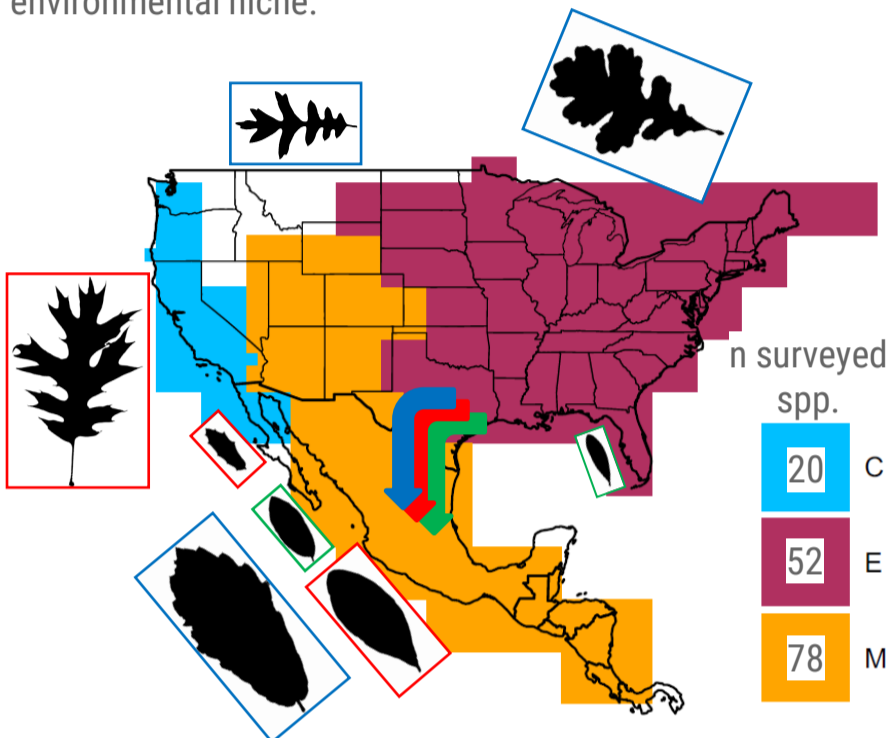


Fig 1. Bioregions of California Floristic Region (C), Eastern North America (E) & Mesoamerica (M) (Hipp et al. 2018)

**Methods:** We explored functional trait evolution patterns using herbarium surveys of 136 *Quercus* spp. (1820 specimens), with spp. represented by leaf and stem traits and their mean climate and soil niche.

1. Hypothesis: Suites of traits will converge in **Mesoamerica** due to (water and nutrient) environmental stresses and competition.
2. Hypothesis: Freezing tolerance traits may be related to drought tolerance (a preadaptation).
3. Hypothesis: Loss of freezing/drought tolerance traits may allow for better growth and competition in environments where drought and freezing stress are not present.

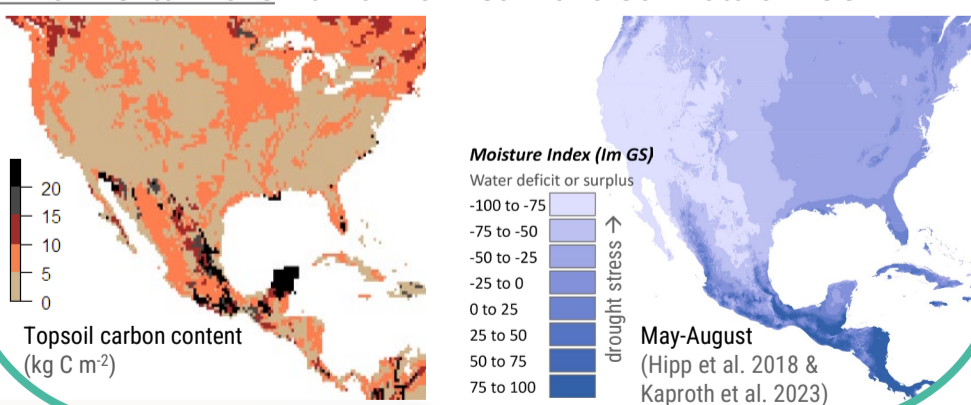
We tested trait relationship correlations by bioregions and if there were any unexpected trait shifts as they diversified going into **Mesoamerica** using PHYLOEM (Bastide et al. 2017).

Tested traits to freezing tolerance & water use:

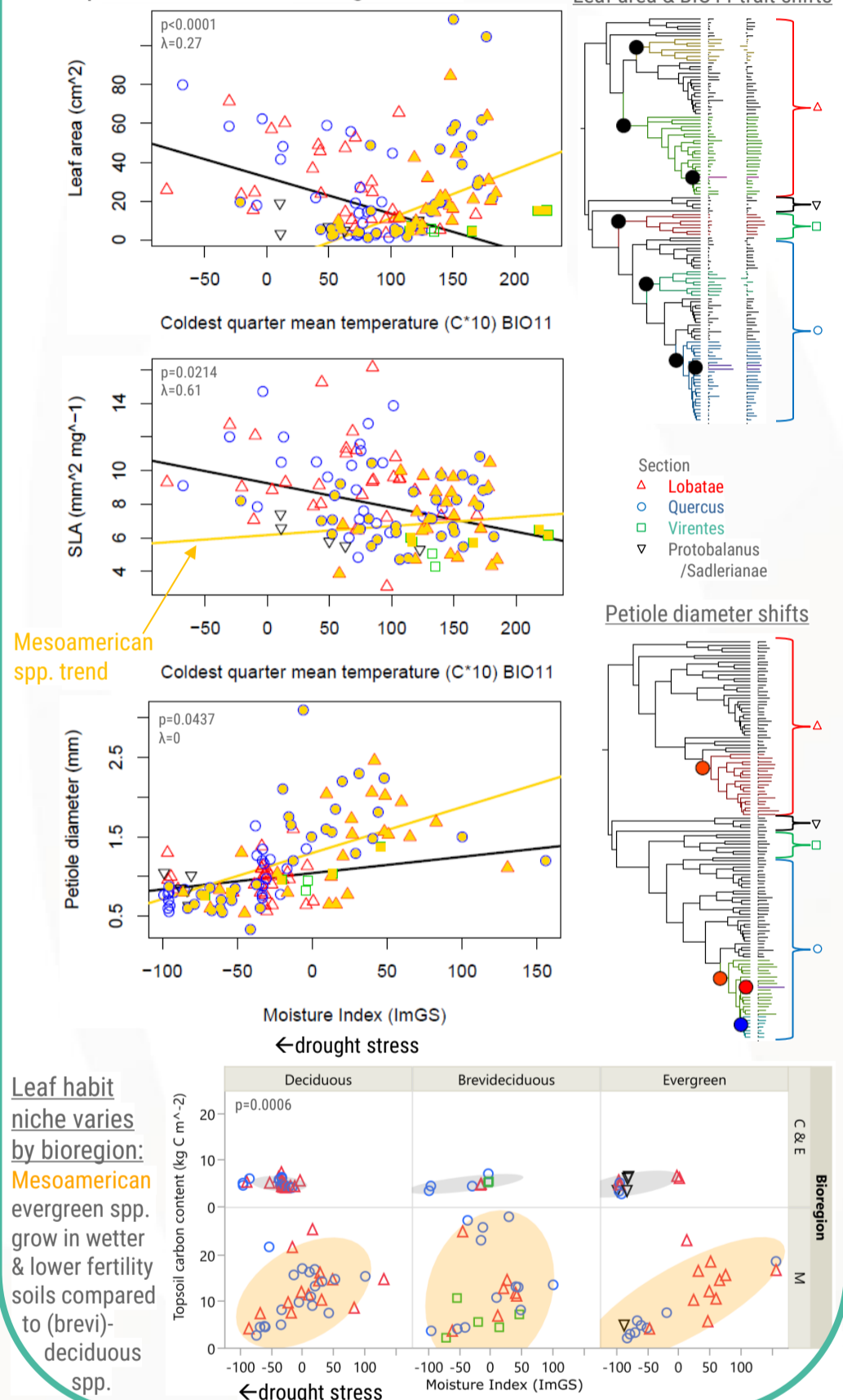
- Petiole Diameter
- Leaf area (smaller leaves in colder climates; Lusk et al. 2018)
- Specific leaf area (SLA)
- Perimeter per unit leaf area (PLA)
- Specific stem density (more dense stems may be better defended (insulated/constructed) to survive some mild freezing temperatures and prevent breaking stems from snow mass)



**Environmental niche** via Harmonized World Soil Data & BIOCLIM



**Results:** Traits like SLA and leaf area are similar among **Lobatae** and **Quercus** sections, but vary by environment and bioregion. Pattern directions change in **Mesoamerica** for leaf area, SLA, petiole diameter & longest leaf.



Leaf habit niche varies by bioregion: **Mesoamerican** evergreen spp. grow in wetter & lower fertility soils compared to (brevi-)deciduous spp.

**Discussion:** Leaf functional traits display convergent patterns in **Mesoamerica** – indicating strong environmental alignment over a broad range of climate and soil conditions.

**Mesoamerican** spp. had ancestral trait shifts associated with growth – larger leaves and petiole diameters – which likely aided their dual expansion into tropical (competitive) environments.

Alignment with Leaf Economic Spectrum: deciduous & brevideciduous spp. tend to grow in more nutrient-rich soils (higher carbon content, lower pH) with seasonal drought and/or freezing.

Consistency across bioregions: cold tolerance traits include higher specific stem density, smaller petiole diameter & smaller leaf area. PLA increases with drought (negative ImGS) & poor soil fertility.



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