

Forest responses to climatic cooling across the Eocene-Oligocene boundary in western North America

Herbert W. Meyer

National Park Service, Florissant, Colorado
Geological Society of America Annual Meeting, 25 September 2016



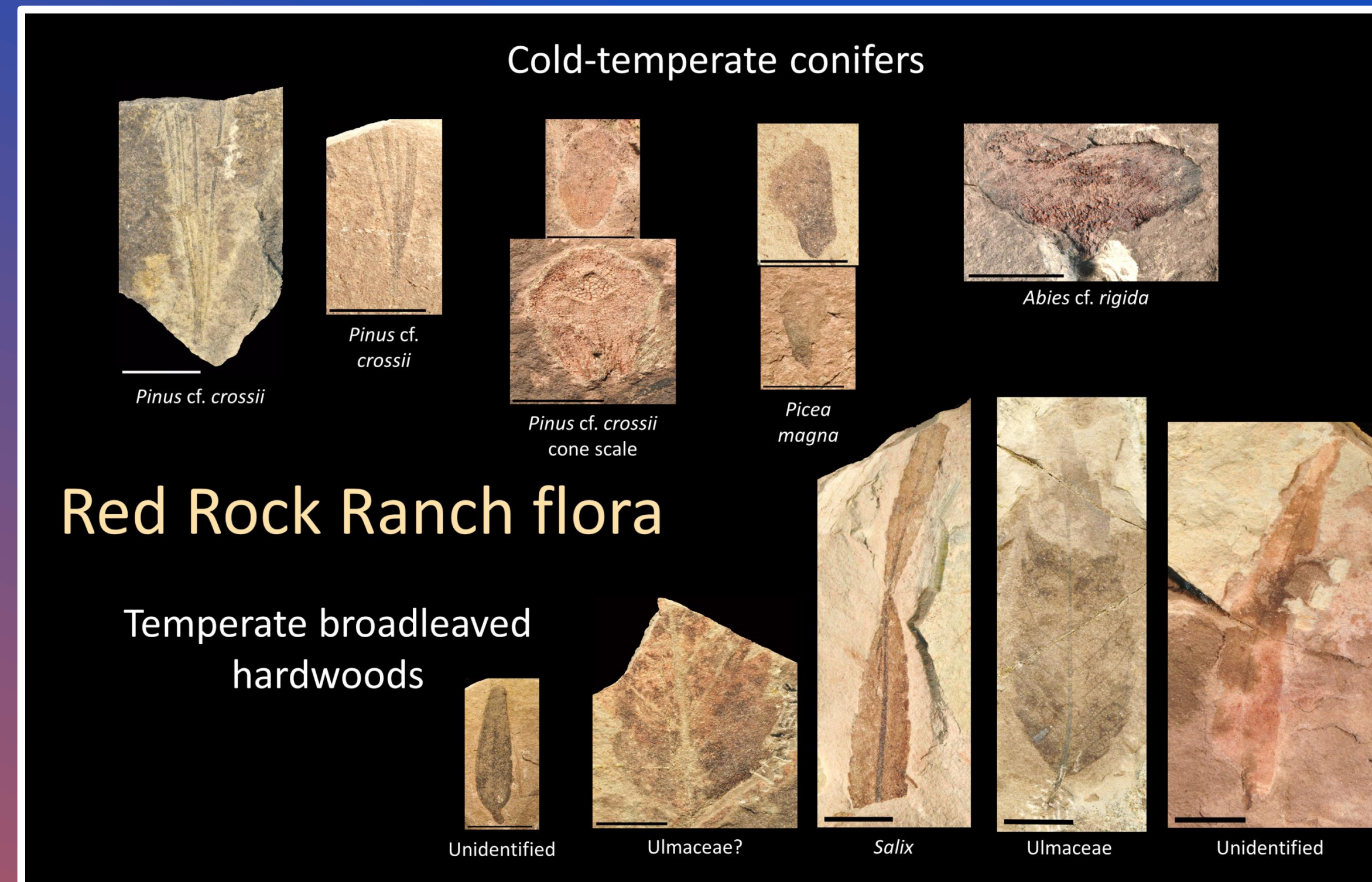
Fossil floras spanning the Eocene-Oligocene transition provide evidence for the responses of forest communities at various elevations to the climatic cooling at the outset of the Oligocene. The particular taxa comprising these communities responded based upon individual ecological tolerances by dispersal to lower elevations, survival within a region due to adaptation or preadapted tolerance ranges, or extinction. The diagram below illustrates examples of these floras and community changes along axes of both temporal and elevation gradients of climate change.

Ecological communities ranged from the warm paratropical forests of the late Eocene (and earliest Oligocene) Pacific coast lowlands (lower left) to the frigid temperate subalpine forests of the early Oligocene high uplands of the continental interior (upper right). Elevation profiles of vegetation changed between the late Eocene and early Oligocene as mean annual temperature cooled significantly and mean annual range of temperature (seasonality) increased. Some of these floras have no close modern analogs whereas others show close similarity to modern forests.

Eocene

Climate cooling during the Eocene-Oligocene transition

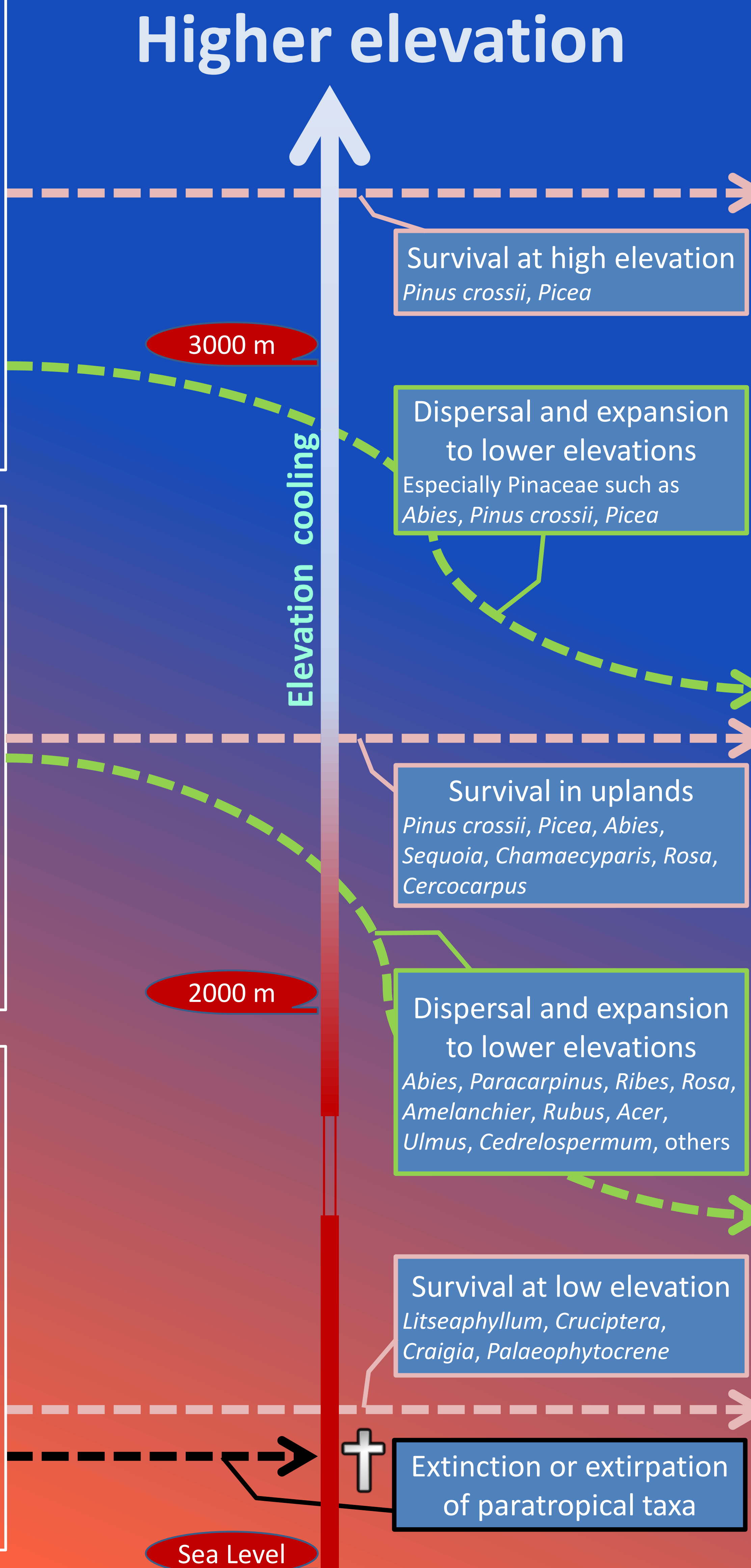
Oligocene



Late Eocene high uplands
Red Rock Ranch flora, New Mexico

- 36.7 ± 1.1 Ma
- Small collection including a mix of conifers and broadleaved deciduous taxa
- Mixed Coniferous pine-spruce-fir forest
- Mean annual temperature 5-10°C
- Paleoelevation 3000-3800 m

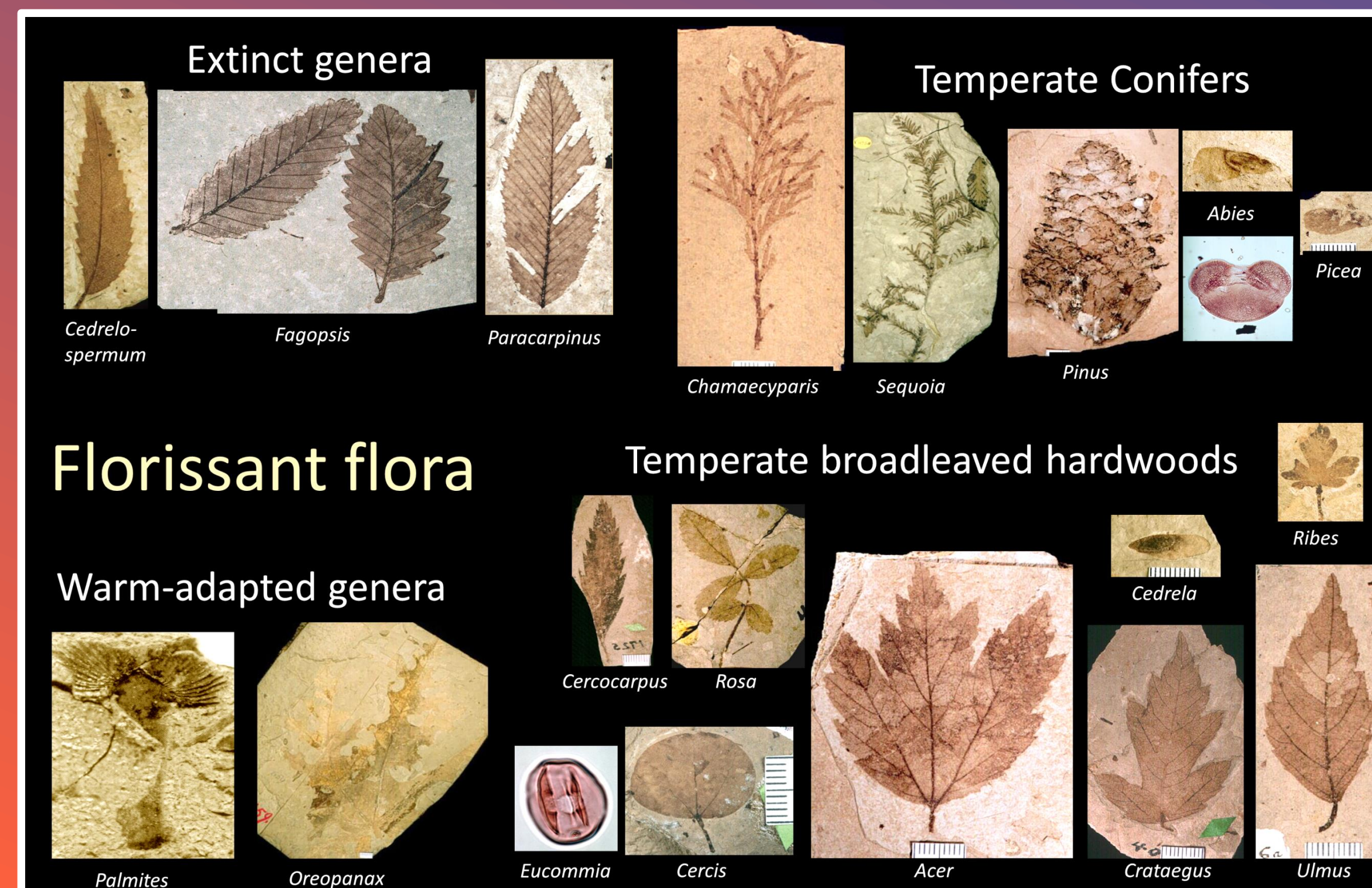
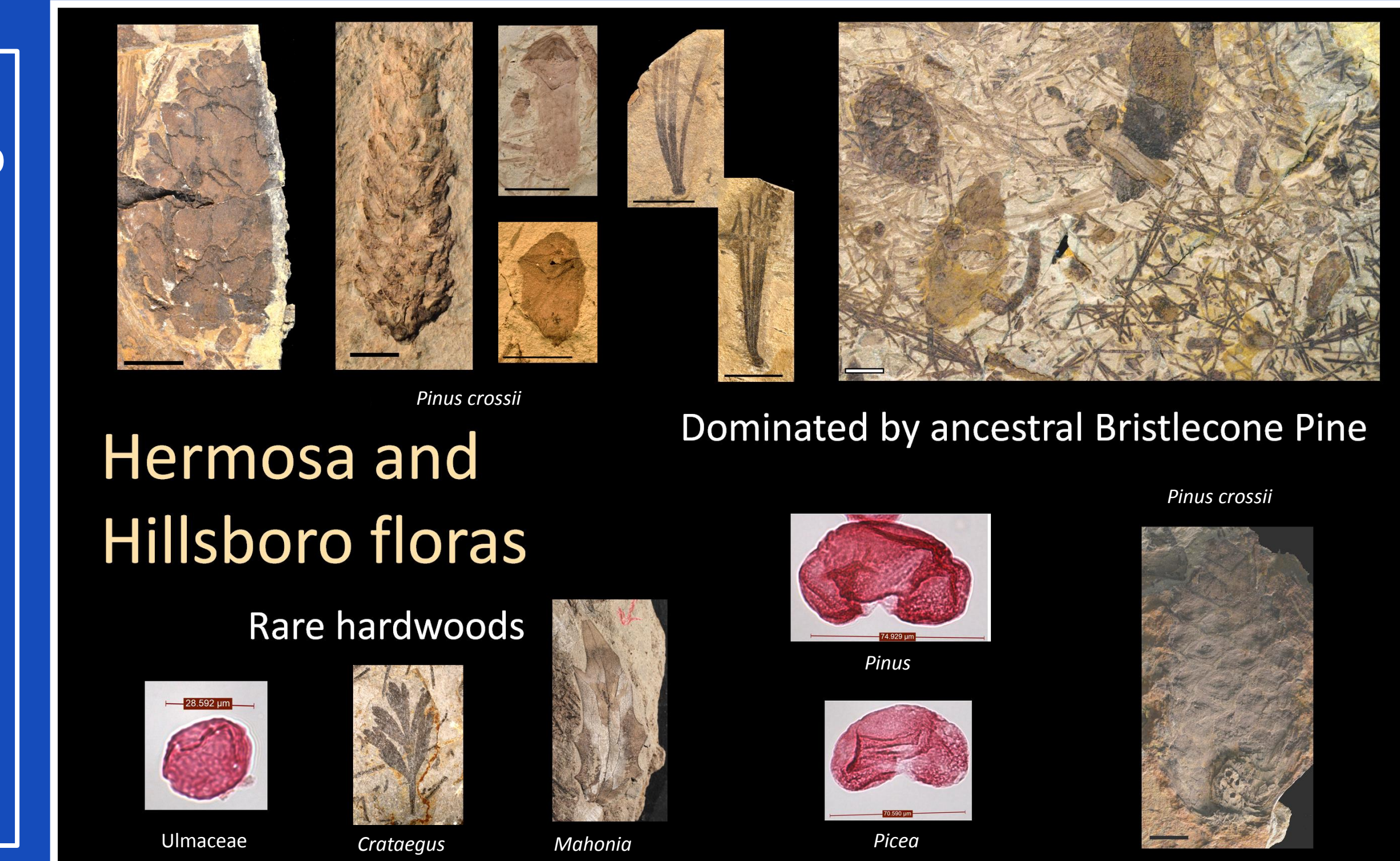
Coniferous forest



Early Oligocene high uplands
Hermosa and Hillsboro floras, New Mexico

- Hermosa 33.6 ± 1.0 Ma; Hillsboro 28.1-31.7 Ma
- Huge collections dominated by *Pinus crossii* (Bristlecone pine), with sparse shrubs
- Subalpine taiga-like forest
- Mean annual temperature -2 to +3°C
- Paleoelevation 3000 m

Subalpine Bristlecone Pine forest



Late Eocene uplands
Florissant flora, Colorado

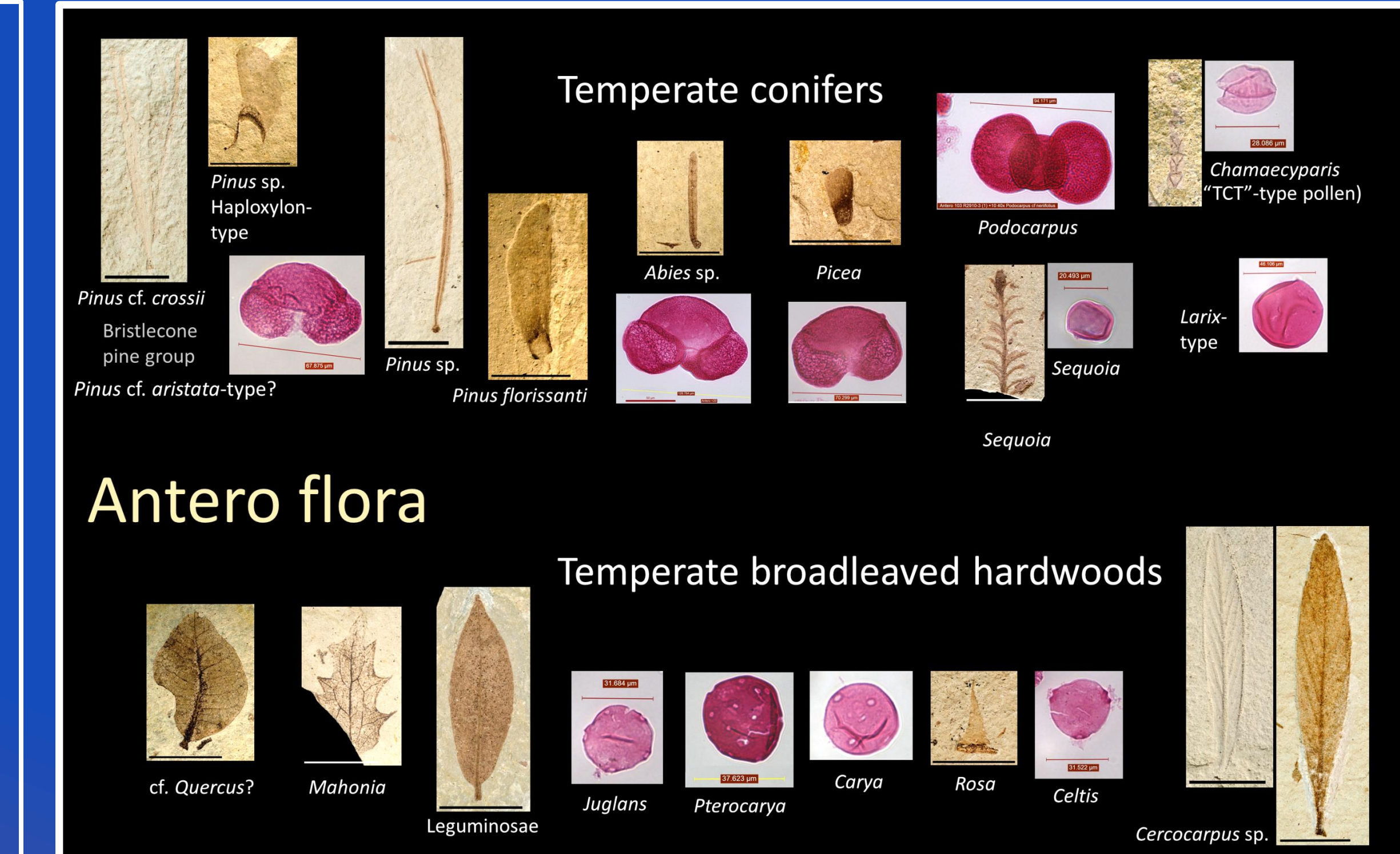
- 34.07 Ma
- Mix of conifers, broadleaved deciduous taxa, broadleaved evergreen taxa, and one palm
- Broadleaved hardwood forest with conifers
- Mean annual temperature 13-15°C (this study, but other estimates range 10-18°C)
- Paleoelevation 2450 m

Cloud forest of Mexico
Coast Redwood forest
(No exact modern analog)

Early Oligocene uplands
Antero flora, Colorado

- 33.76 Ma
- Small macrofossil collection and large pollen assemblage
- Mixed Coniferous pine-spruce-fir forest with tall Cupressaceae and low understory hardwoods
- Mean annual temperature 5-13°C (larger sample needed for better determination)
- Paleoelevation similar to Florissant (2450 m)

Coniferous forest



Late Eocene (and earliest Oligocene pre-cooling) lowlands
Comstock and Goshen floras, Oregon

- Comstock 39.7 Ma; Goshen 33.4-34.8 Ma
- High diversity of broadleaved evergreens, many with entire margins and drip tips
- Paratropical Rain forest
- Mean annual temperature 19-23°C
- Paleoelevation near sea level (associated with marine beds)

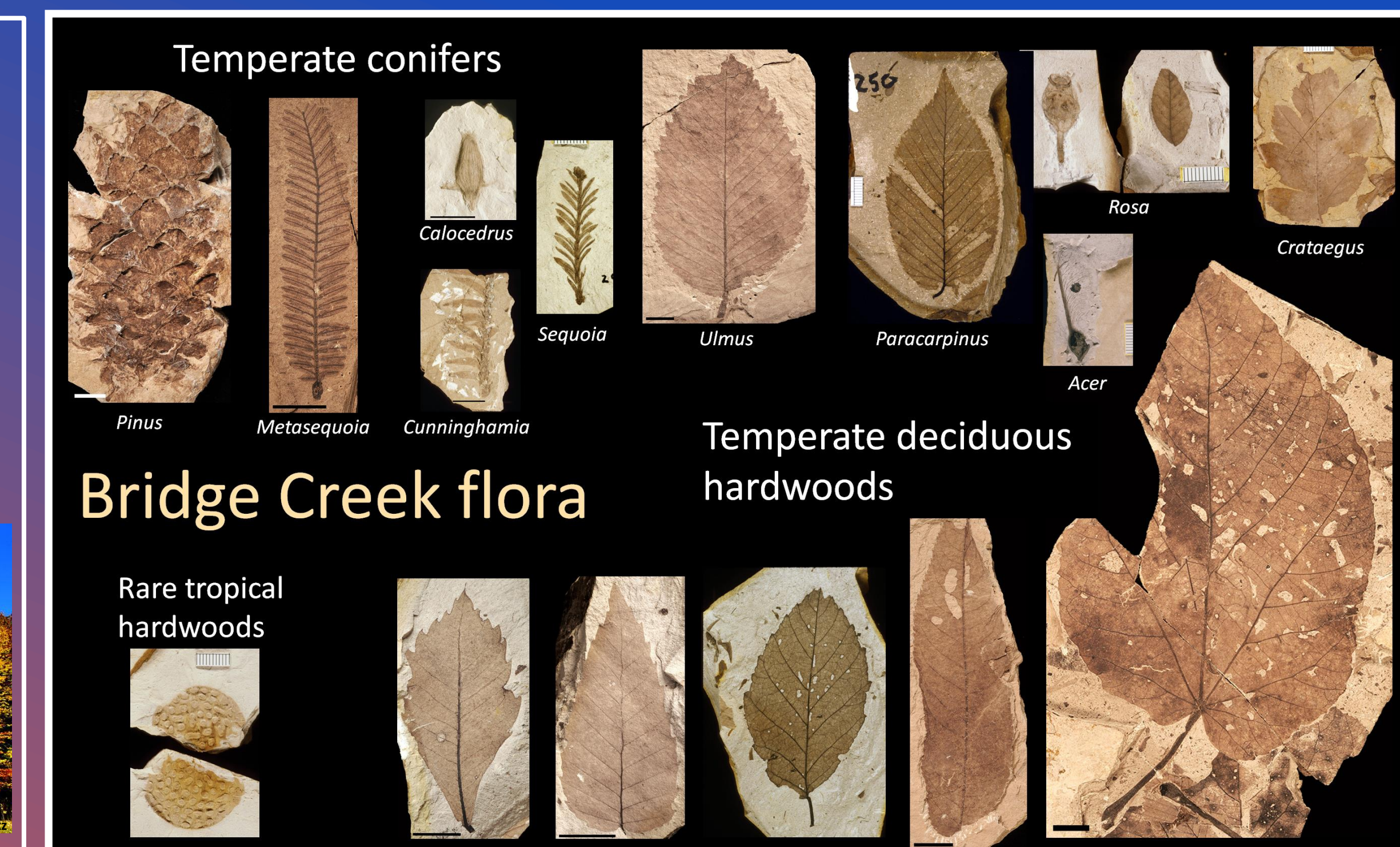
Paratropical Rain forest

Early Oligocene lowlands
Bridge Creek flora, Oregon

- 32.2-33.6 Ma
- Large macrofossil collections dominated by temperate broad-leaved deciduous taxa with some conifers
- Mixed Mesophytic forest
- Mean annual temperature 9-11°C
- Paleoelevation 700-1200 m

Mixed Mesophytic forest

Broad-leaved deciduous forest



Acknowledgements Pollen photos and identifications provided by Stephanie Zaborak and Estella Leopold. Some Bridge Creek photos provided by Alex Catalano, Catherine Snyder, Jane Blanchard, and Hongshan Wang. Macrofossil specimens from Yale Peabody Museum, University of California Museum of Paleontology, U.S. Geological Survey, and University of Florida Museum of Natural History. Assistance with poster compilation provided by Conni O'Connor and Carolyn Thornton.