



What fossil plants can tell us about climate change



Dana Royer



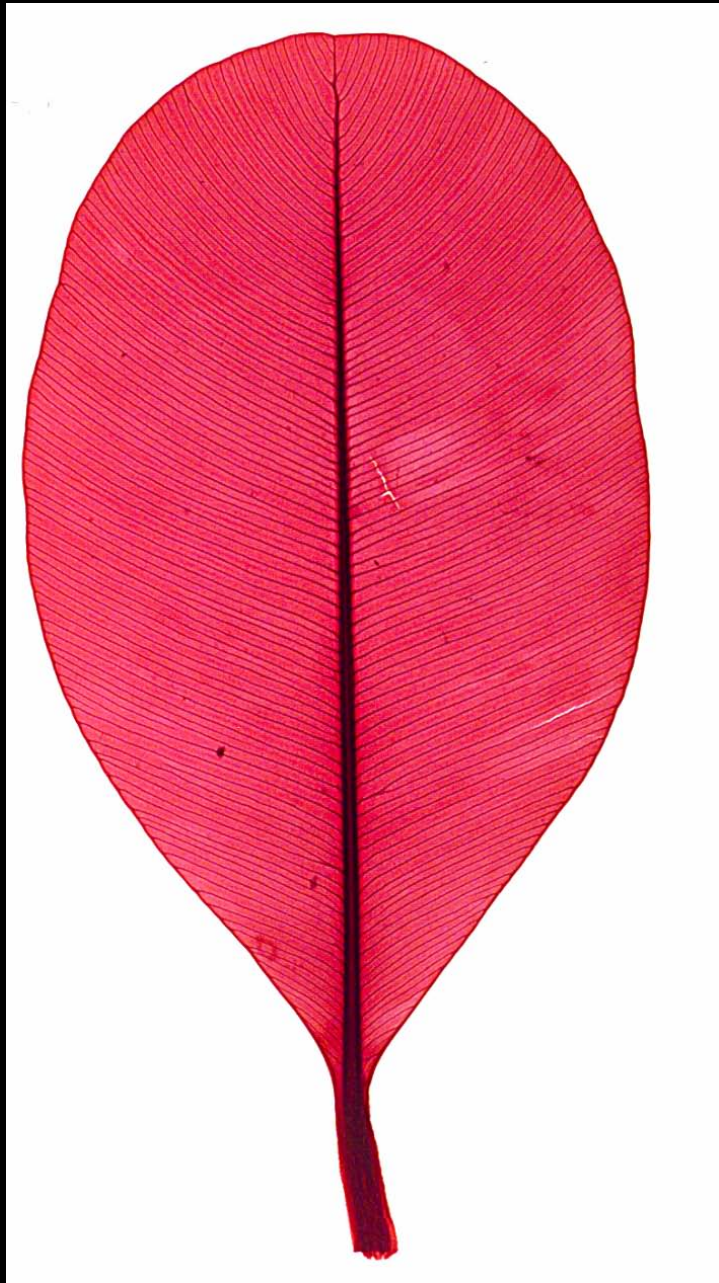
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Arctic during the Late Cretaceous (90 million years ago)



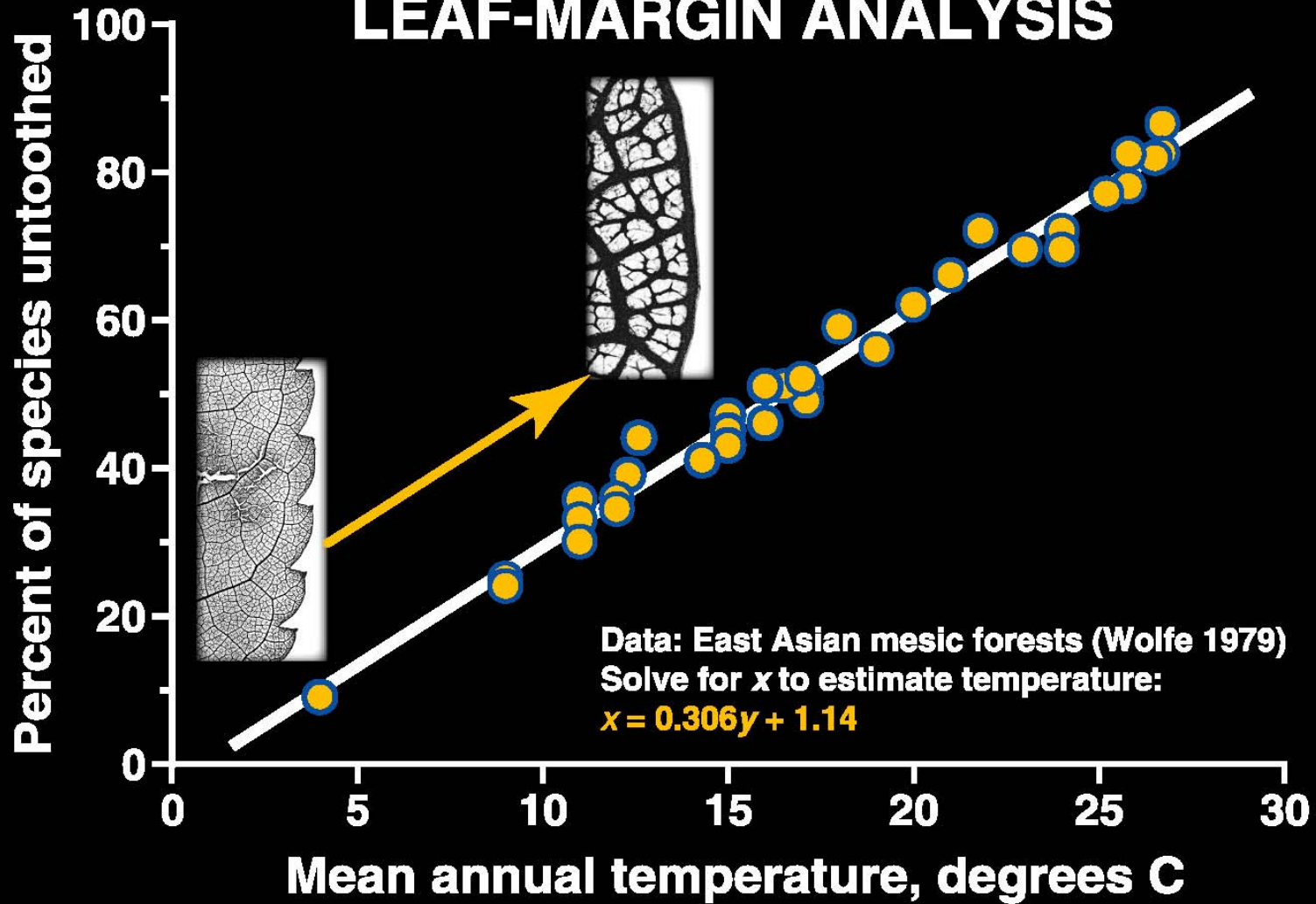
Artwork by Rebecca Horwitt

Leaf teeth and climate



Leaf teeth and climate

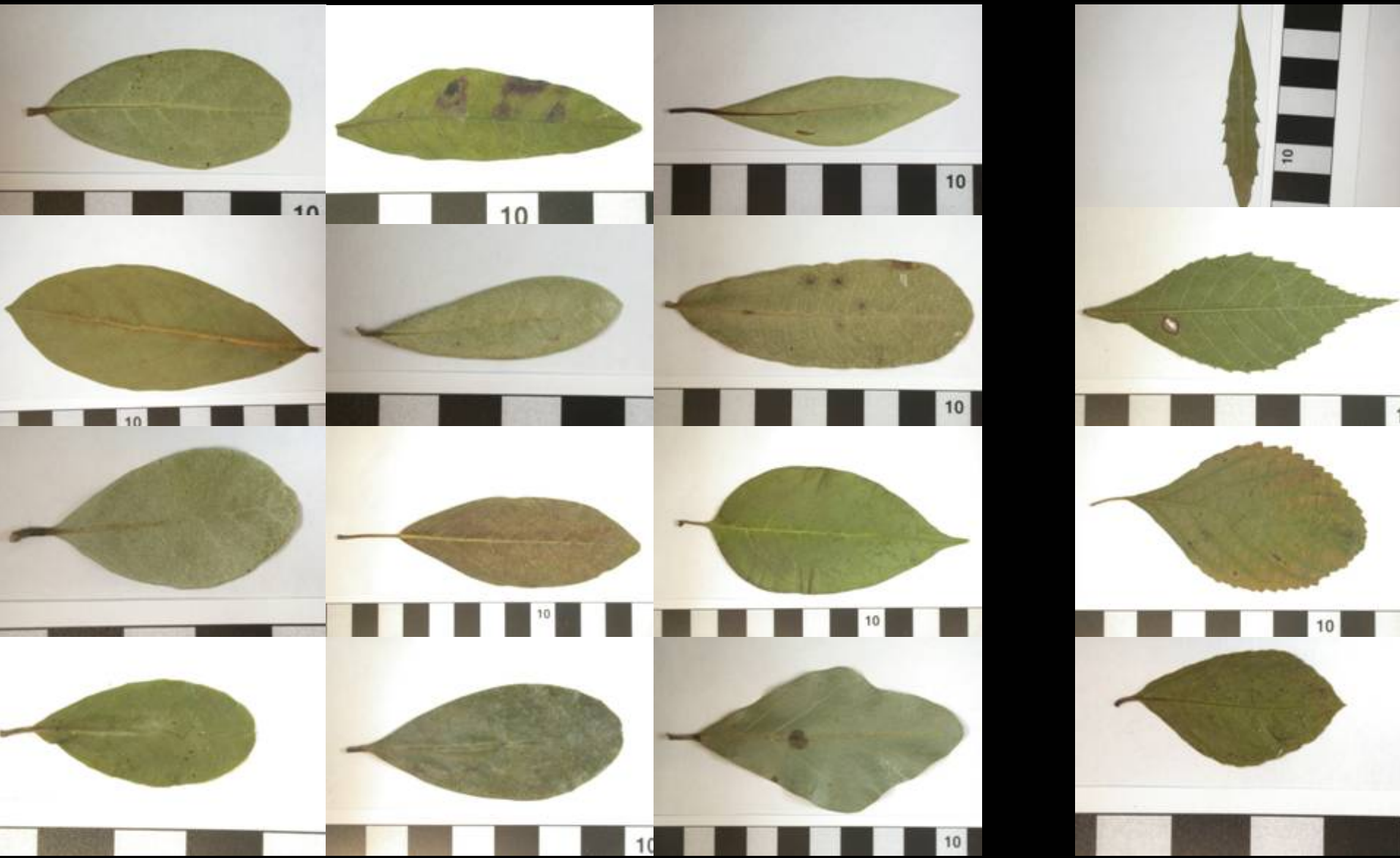
LEAF-MARGIN ANALYSIS



Florida Panther Refuge (FL)

MAT = 22.3 °C

Leaf margin % = 64 % (MAT = 21.0 °C)



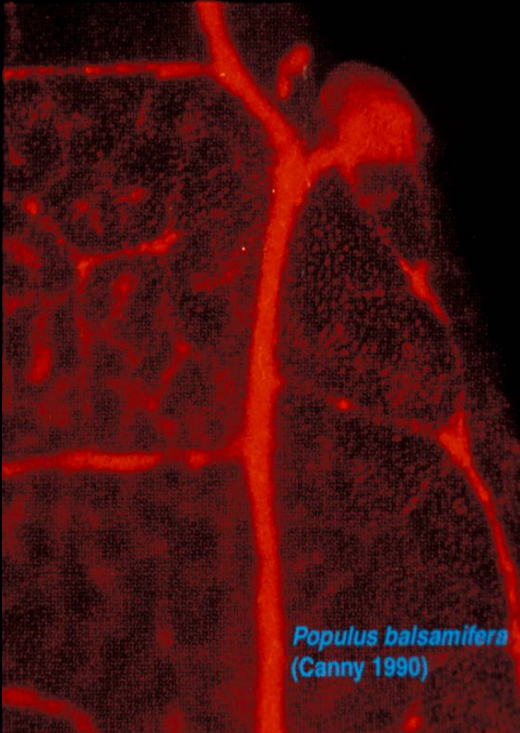
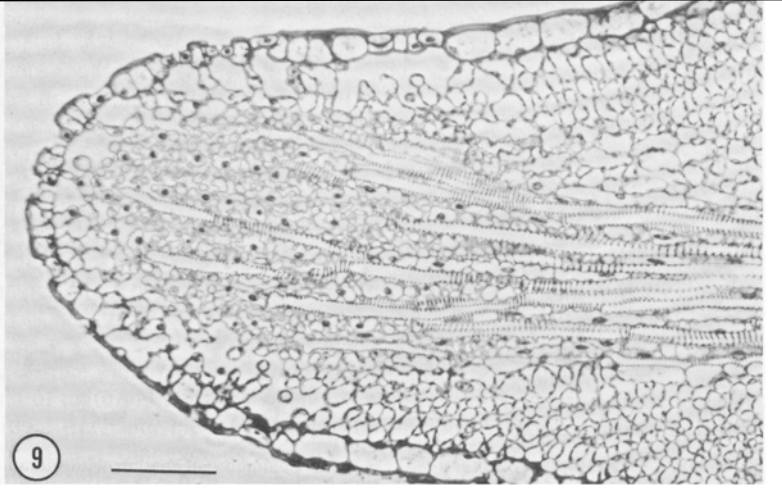
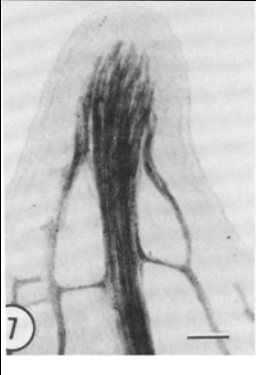
Hubbard Brook Experimental Forest (NH)

MAT = 4.5 °C

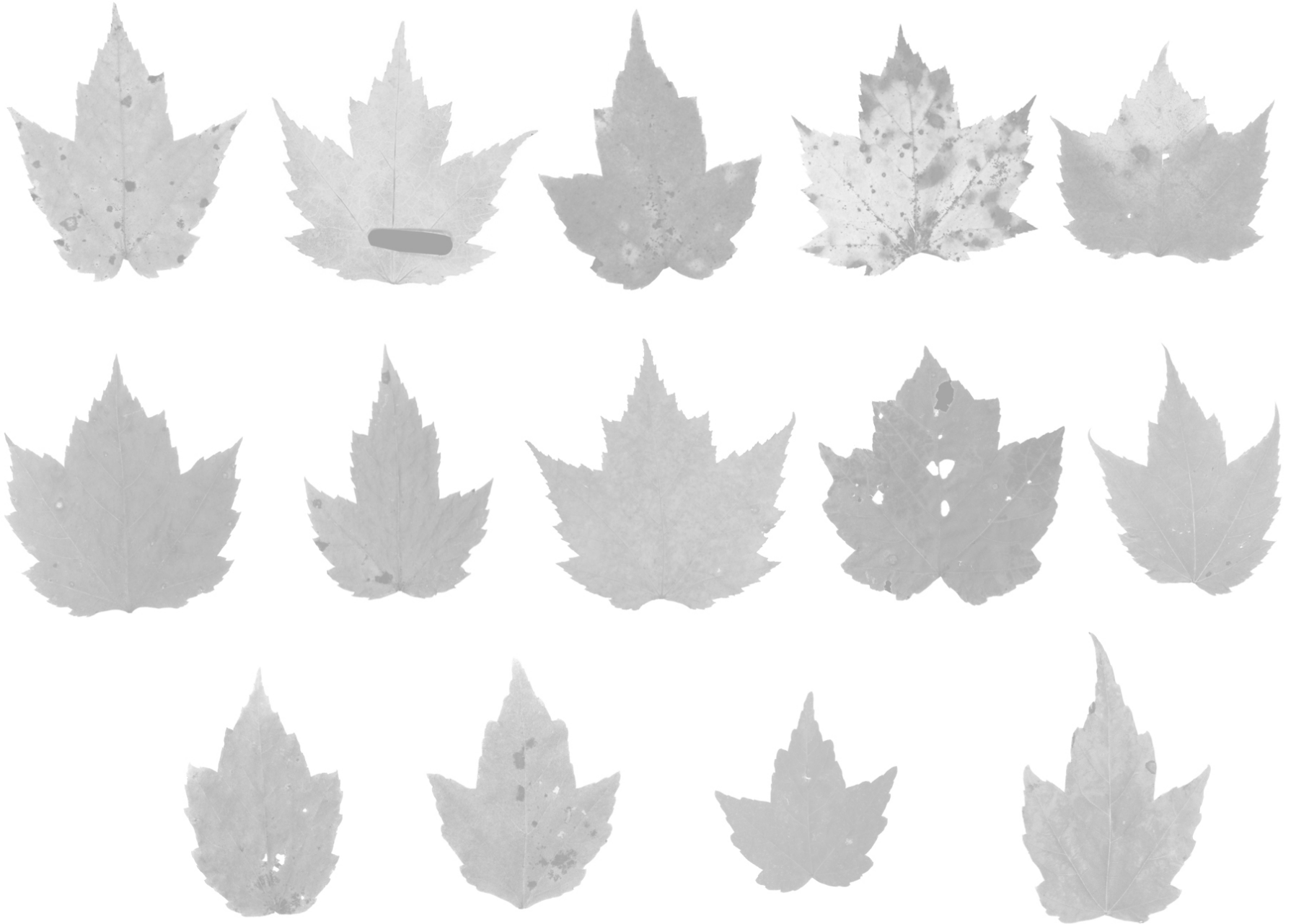
Leaf margin % = 9 % (MAT = 3.8 °C)



Leaf teeth increase sap flow and photosynthesis



It's more than just presence / absence of teeth



Processing modern leaves

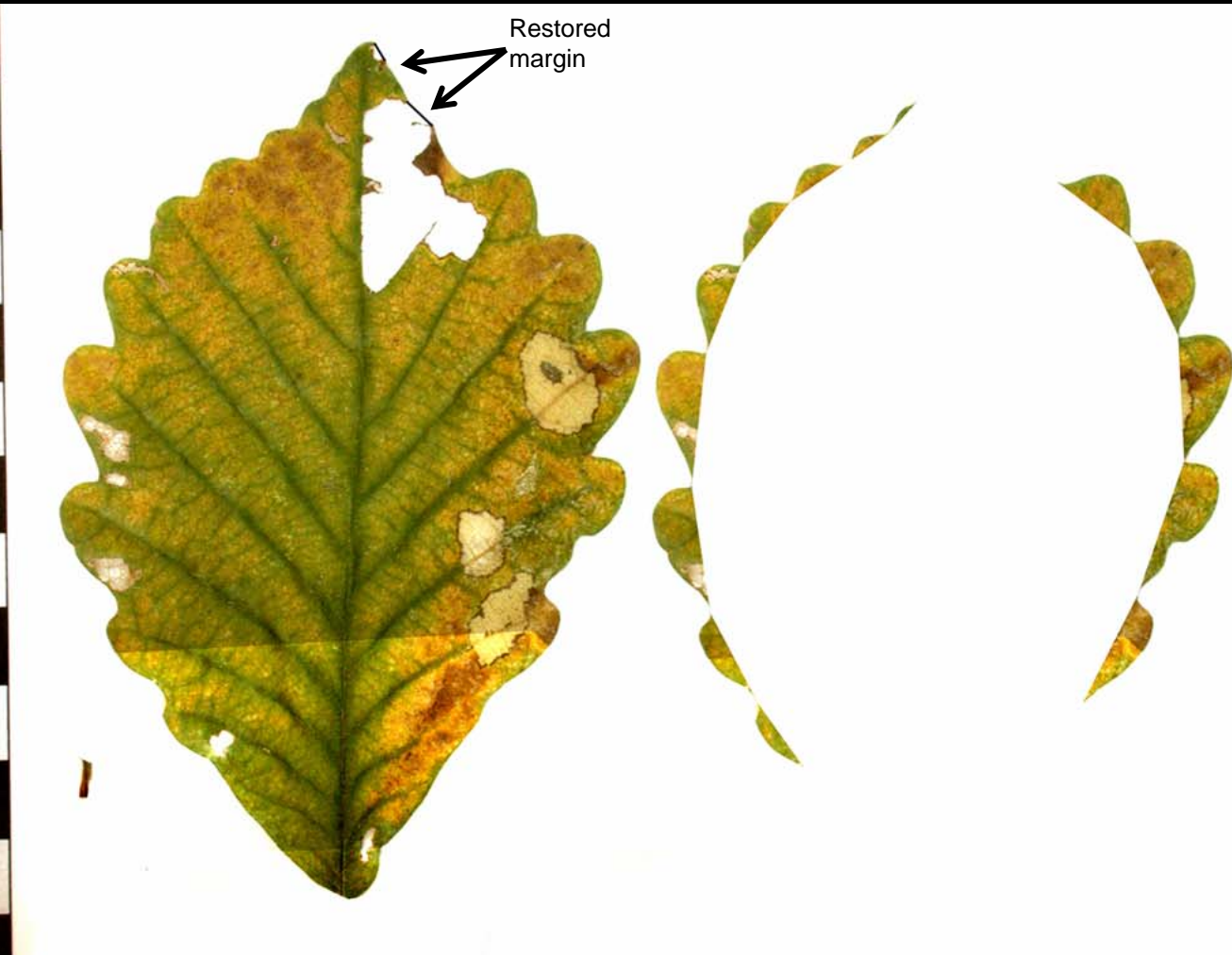


Processing modern leaves



Background cleaned, petiole removed, and margins restored using Adobe Photoshop

Processing modern leaves



Background cleaned, petiole removed, and margins restored using Adobe Photoshop

Tooth selection

Processing modern leaves

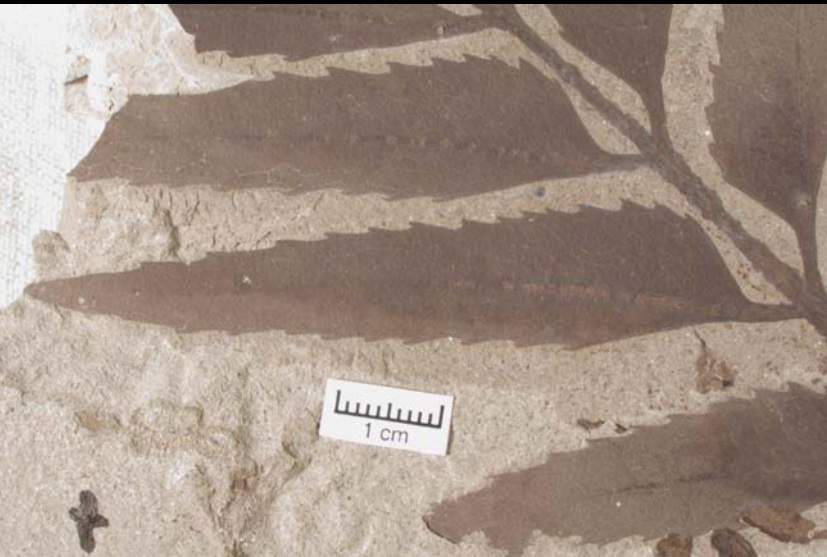


Background cleaned, petiole removed, and margins restored using Adobe Photoshop

Tooth selection

Leaf minus teeth

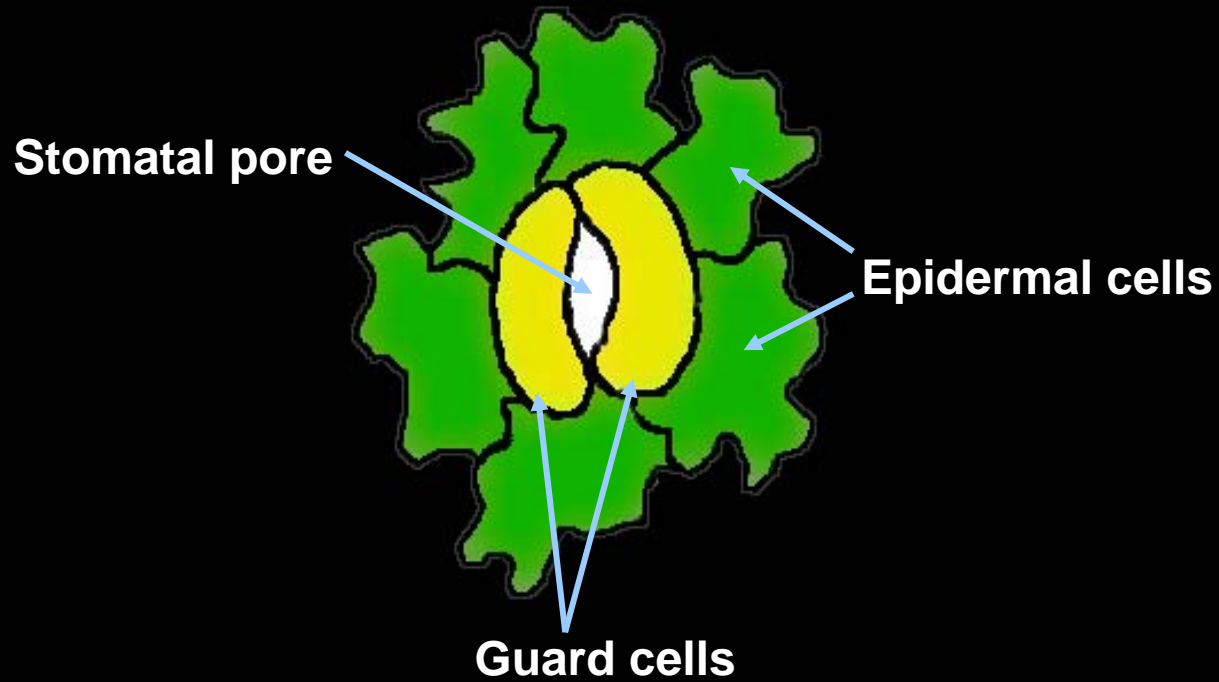
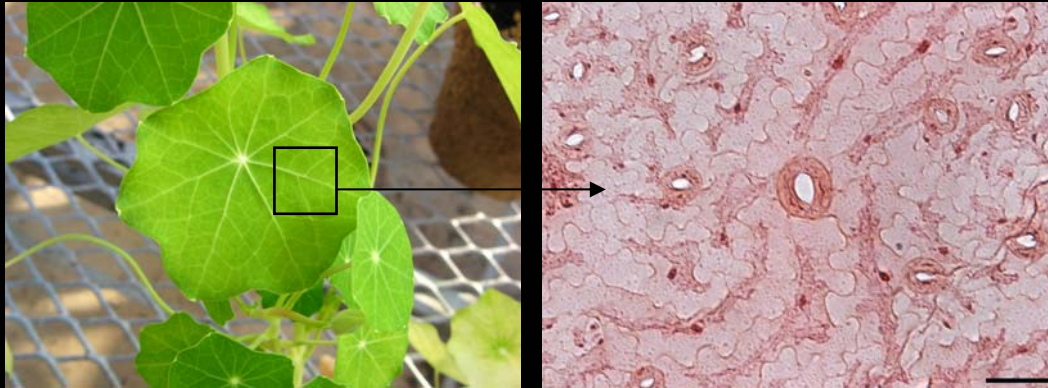
Processing fossil leaves



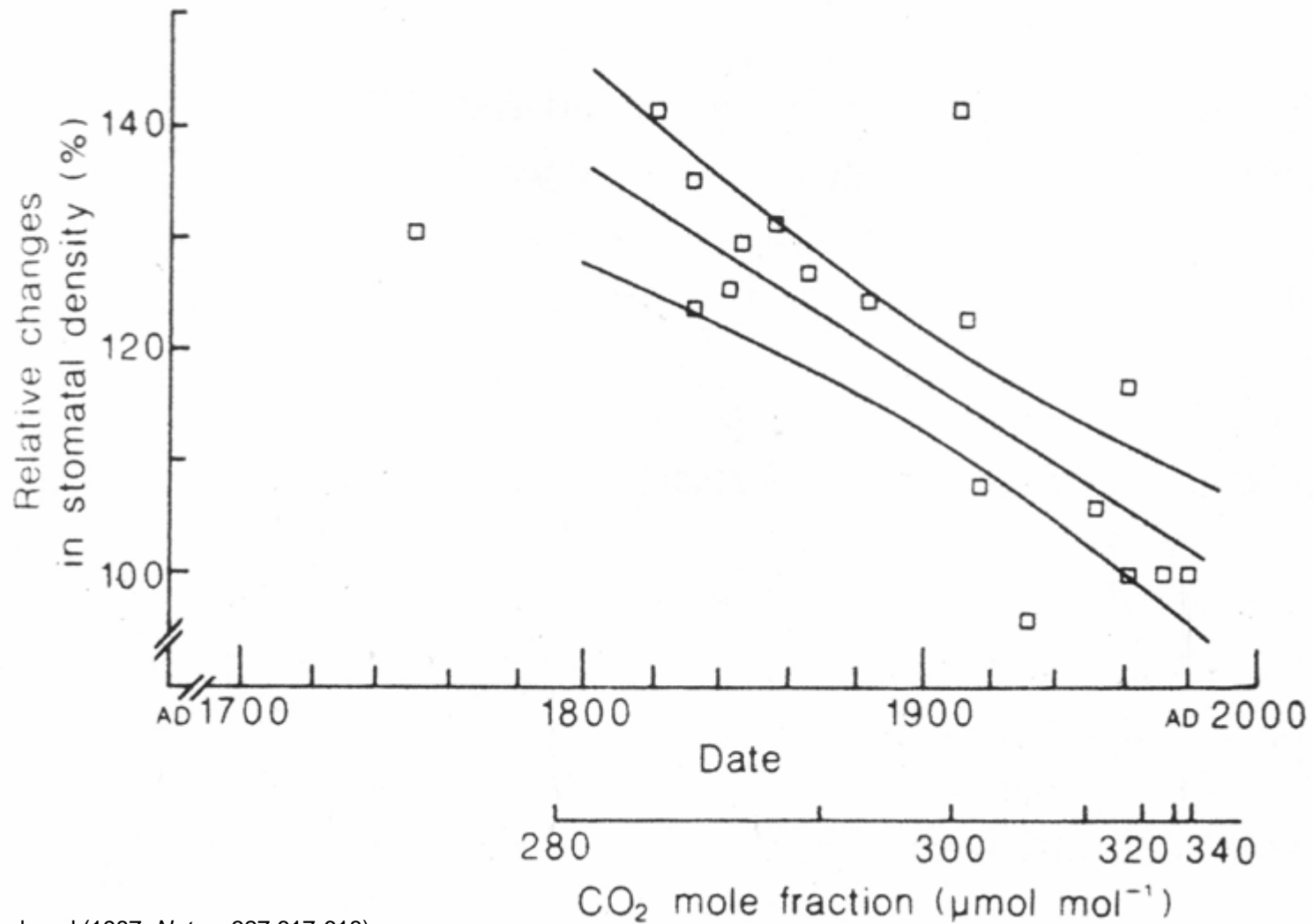
TY 26 (*Lomatia preferruginea* Berry)



Stomata! Gatekeepers of gas exchange



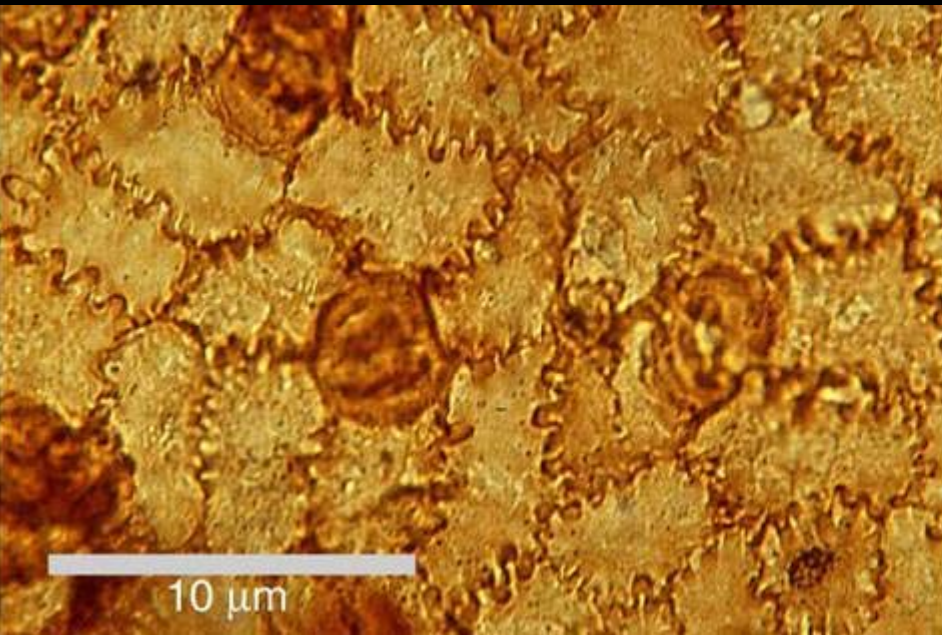
Stomata and atmospheric CO₂



Woodward (1987, *Nature* 327:617-618)

aff. *Stenochlaena* just above the
Cretaceous-Tertiary boundary

modern *Stenochlaena palustris*

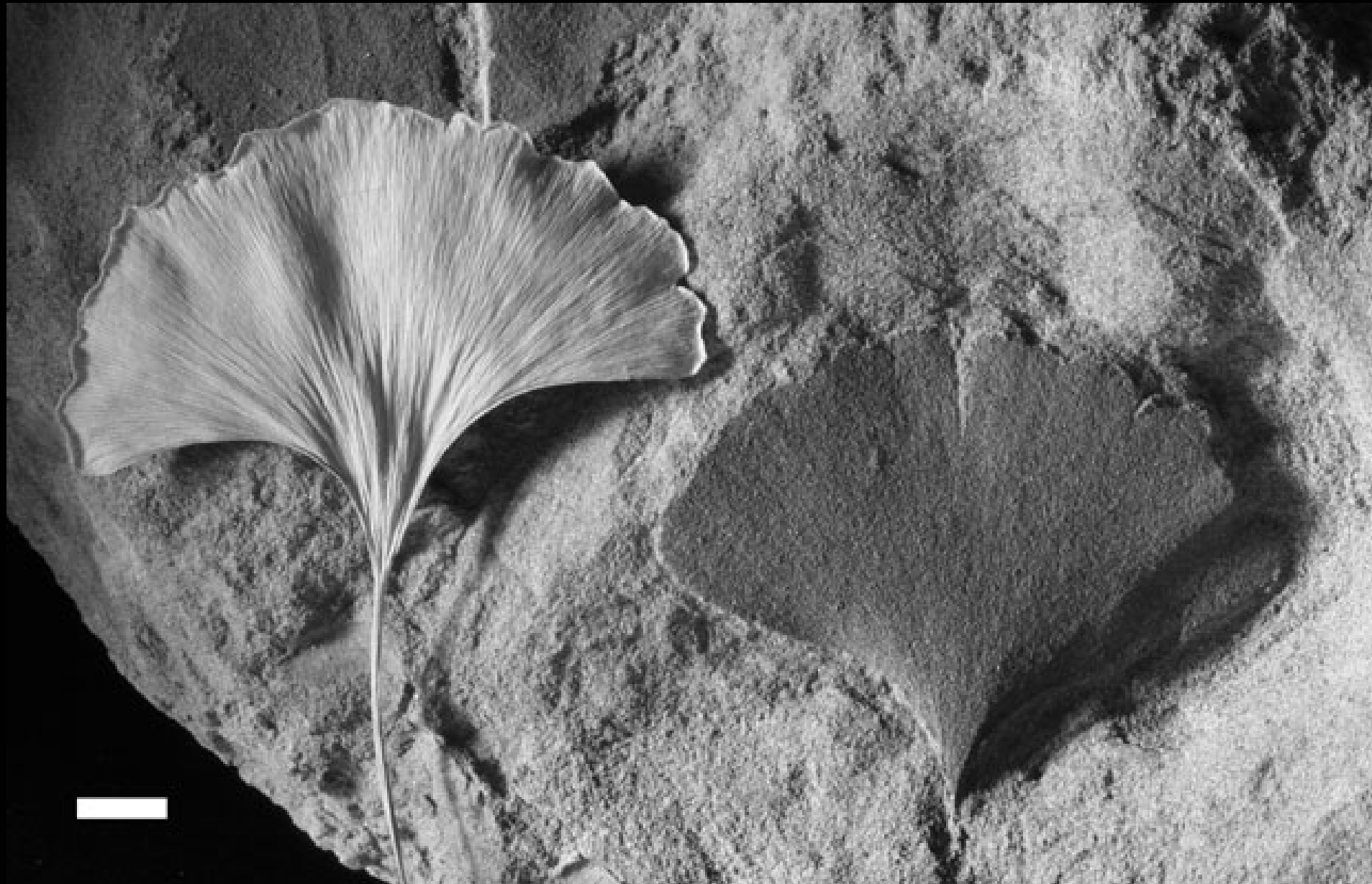


Photos courtesy of B. Lomax



Ginkgo biloba

Comparison of modern *Ginkgo biloba* with Cretaceous *G. adiantoides* (70 million years old)



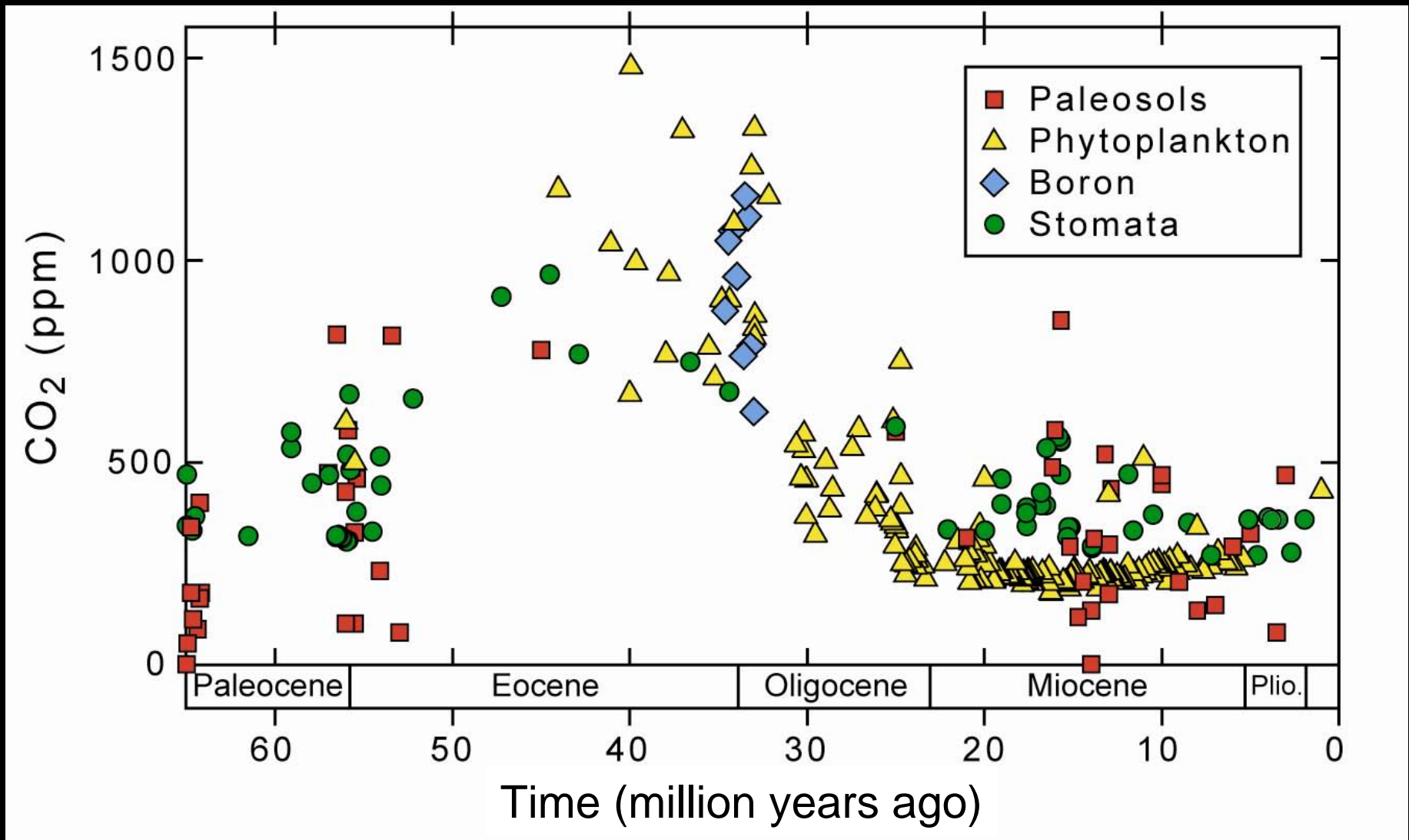
Comparison of modern and fossil *Ginkgo* seeds (60 million years old)



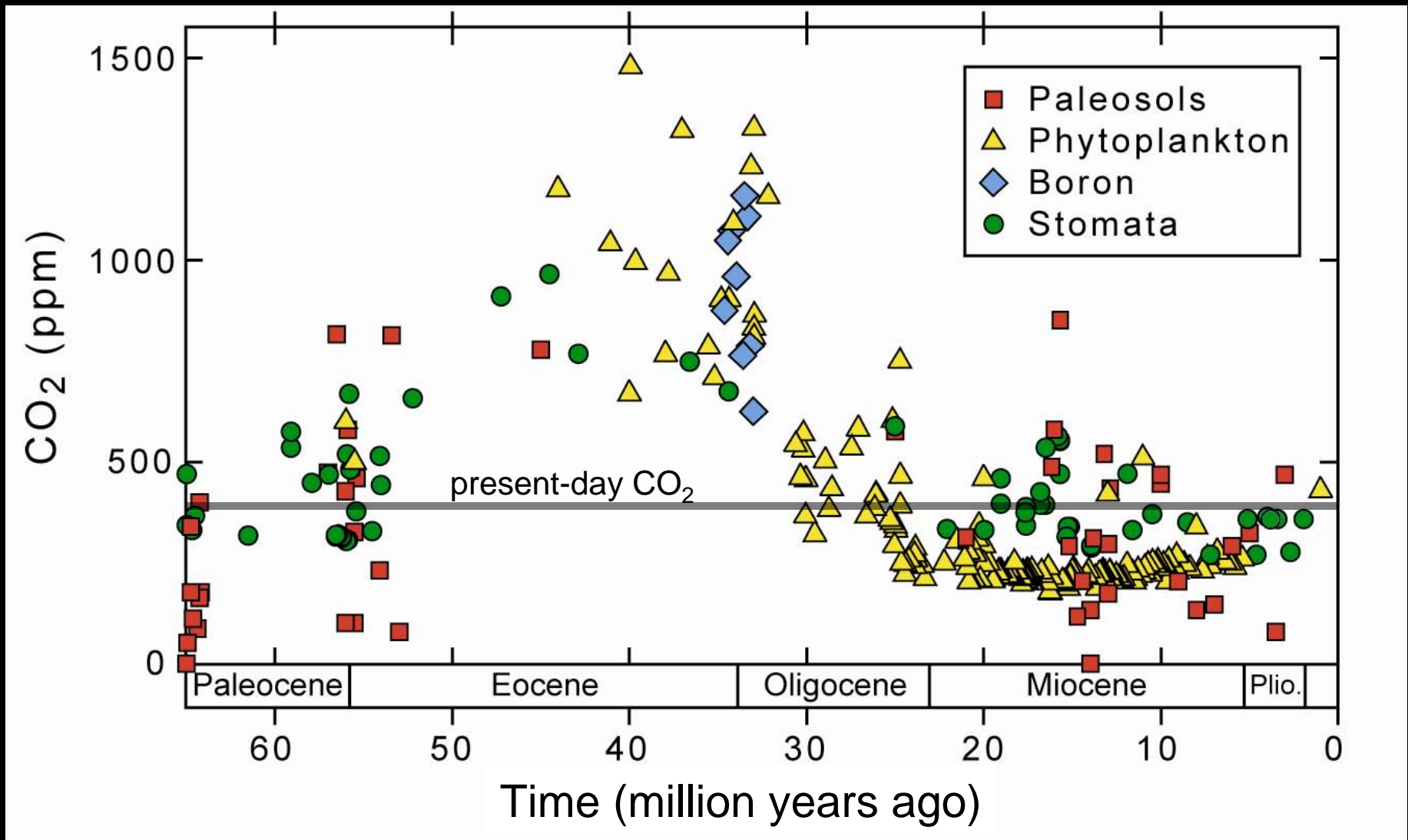


***Metasequoia
glyptostroboides***

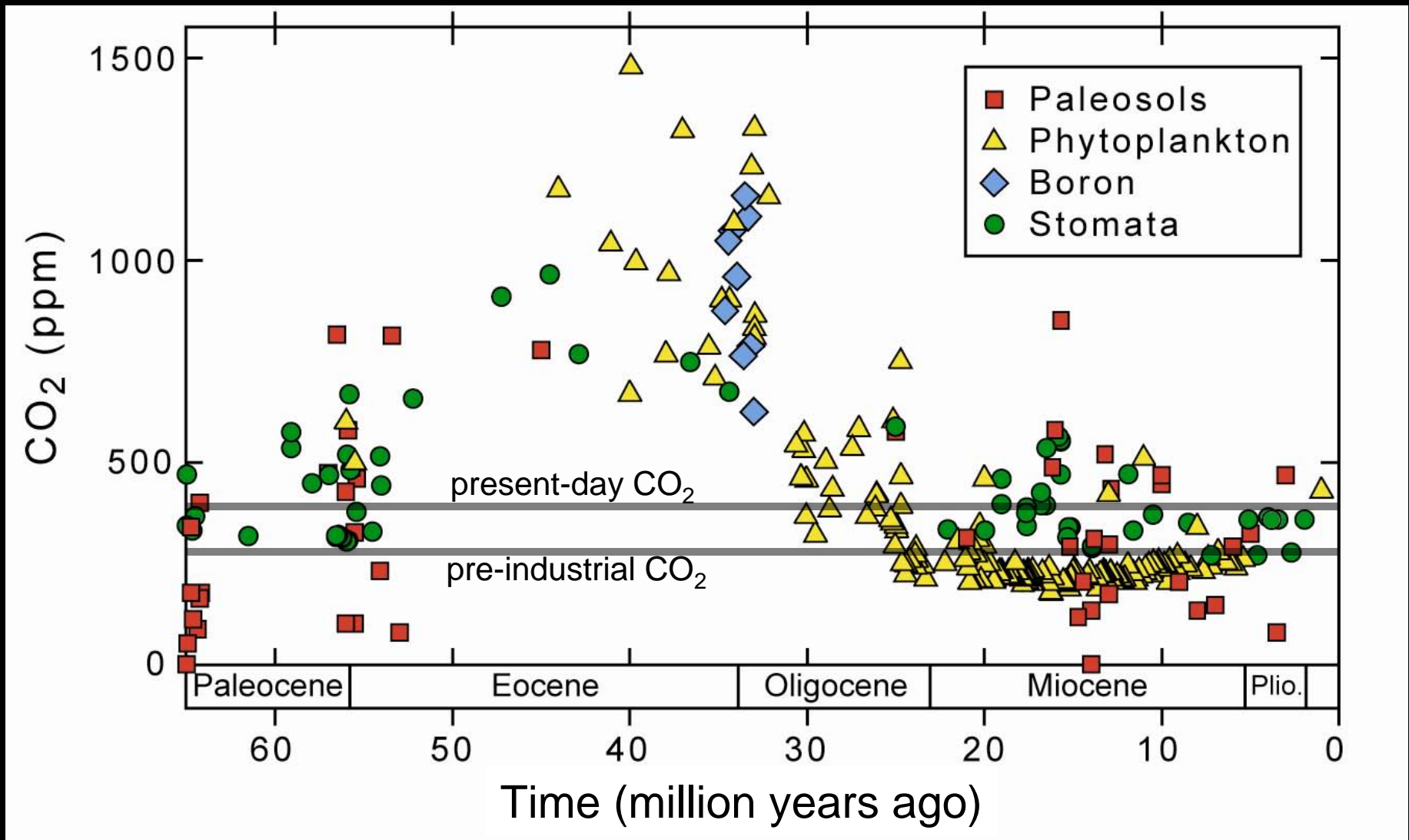
Link between CO₂ and temperature over geologic timescales



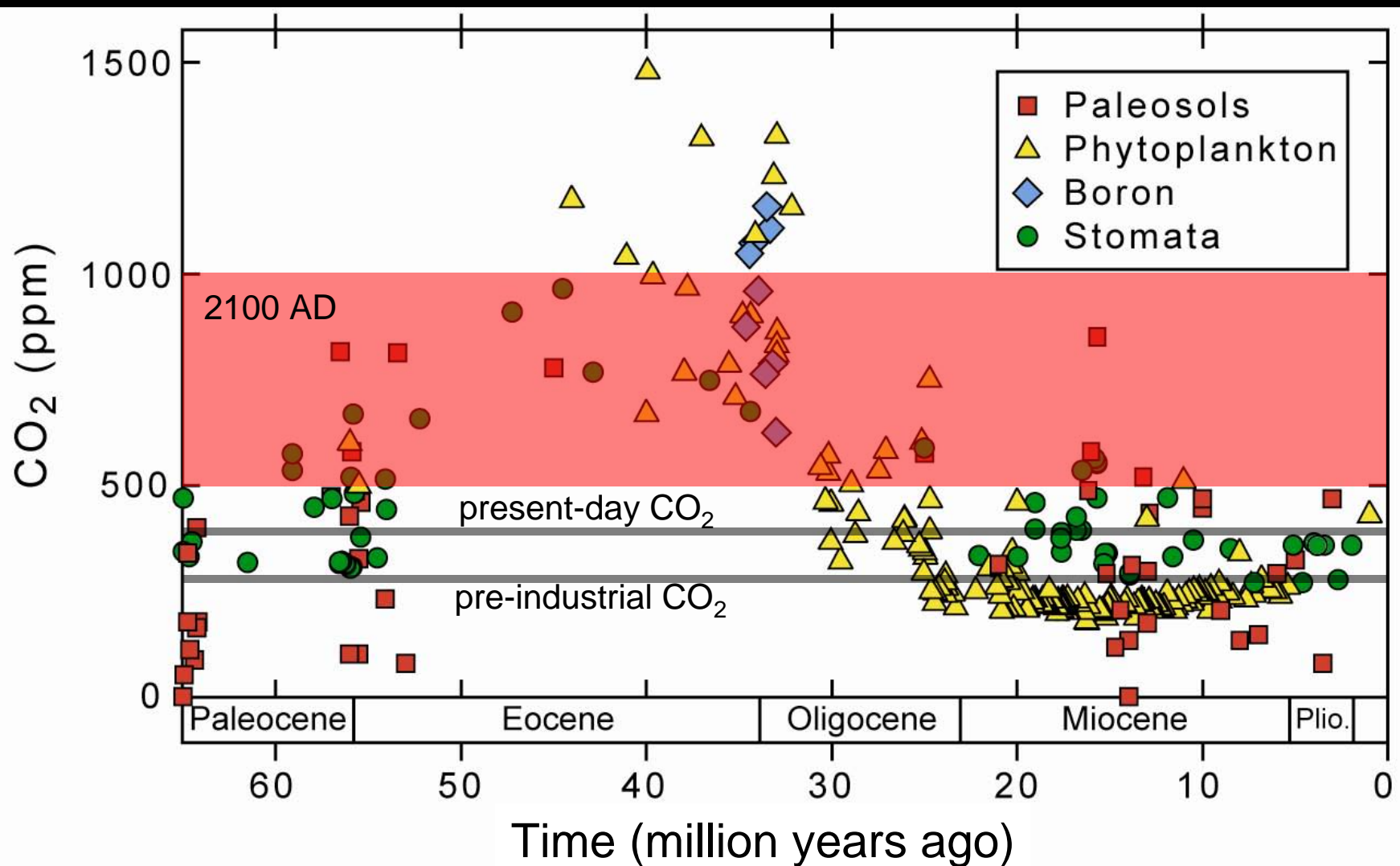
Link between CO₂ and temperature over geologic timescales



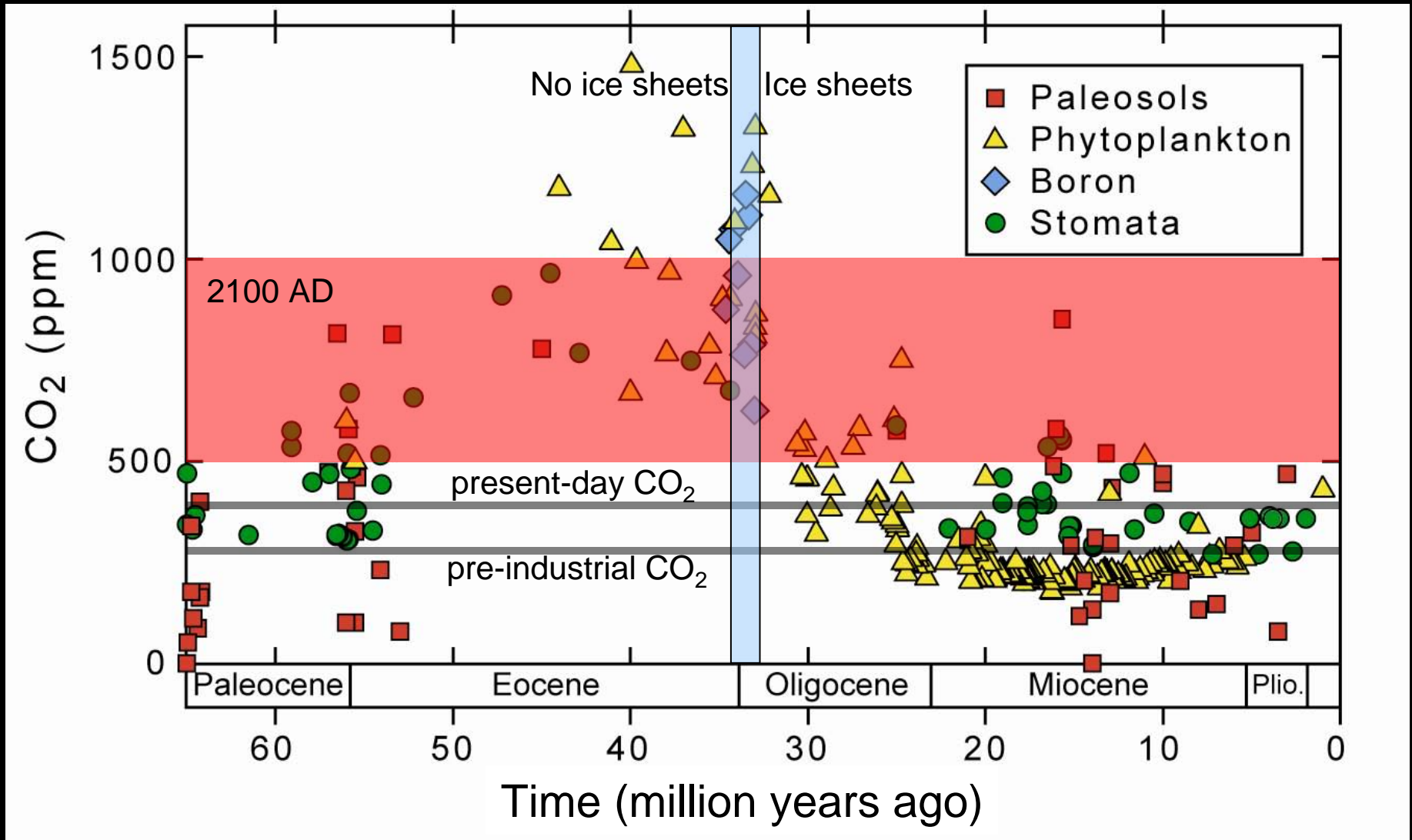
Link between CO₂ and temperature over geologic timescales



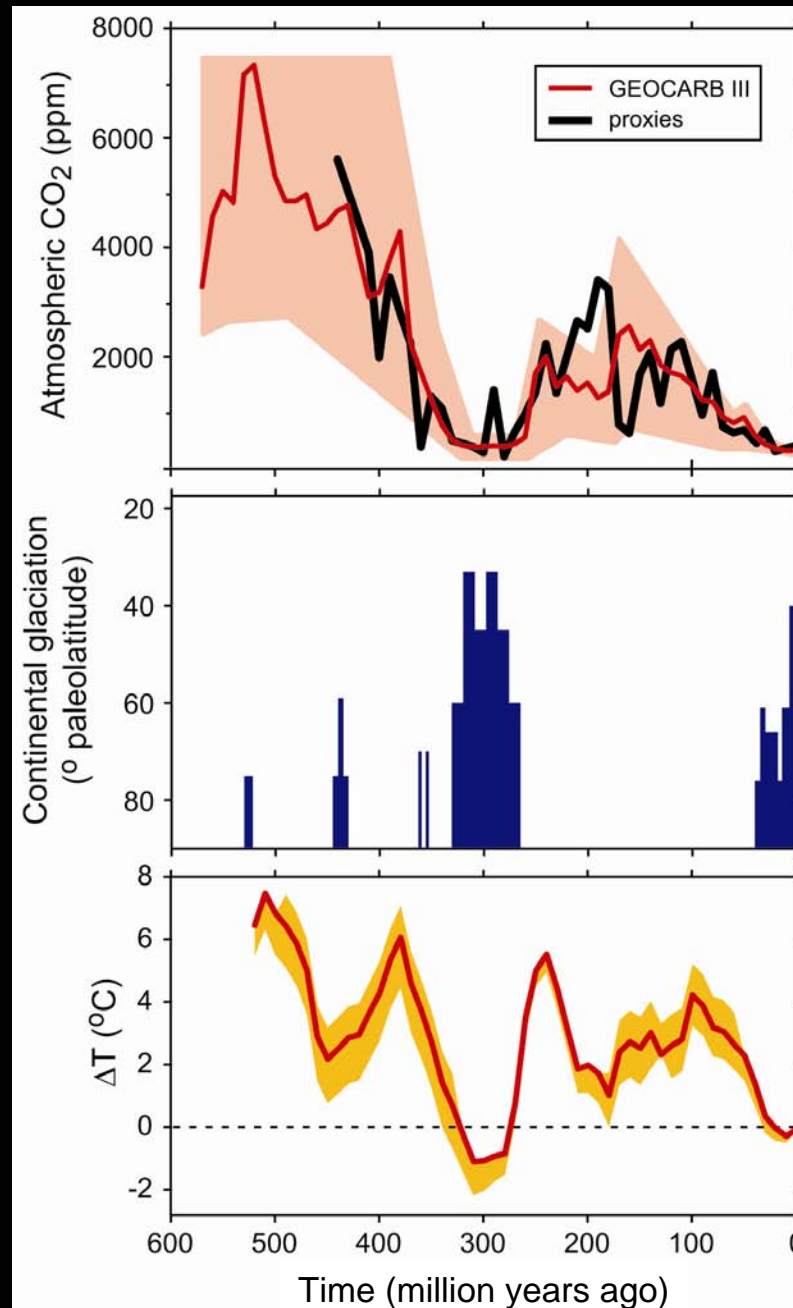
Link between CO₂ and temperature over geologic timescales



Link between CO₂ and temperature over geologic timescales



Link between CO₂ and temperature over geologic timescales



Climate sensitivity

Amount of expected warming (global) for every CO₂ doubling

Estimates of climate sensitivity

Short time scales (<100 yrs): 3 °C (5.5 °F) per CO₂ doubling

**Long (geologic) time scales (>100 yrs): 3-6 °C (up to 11 °F)
per CO₂ doubling**