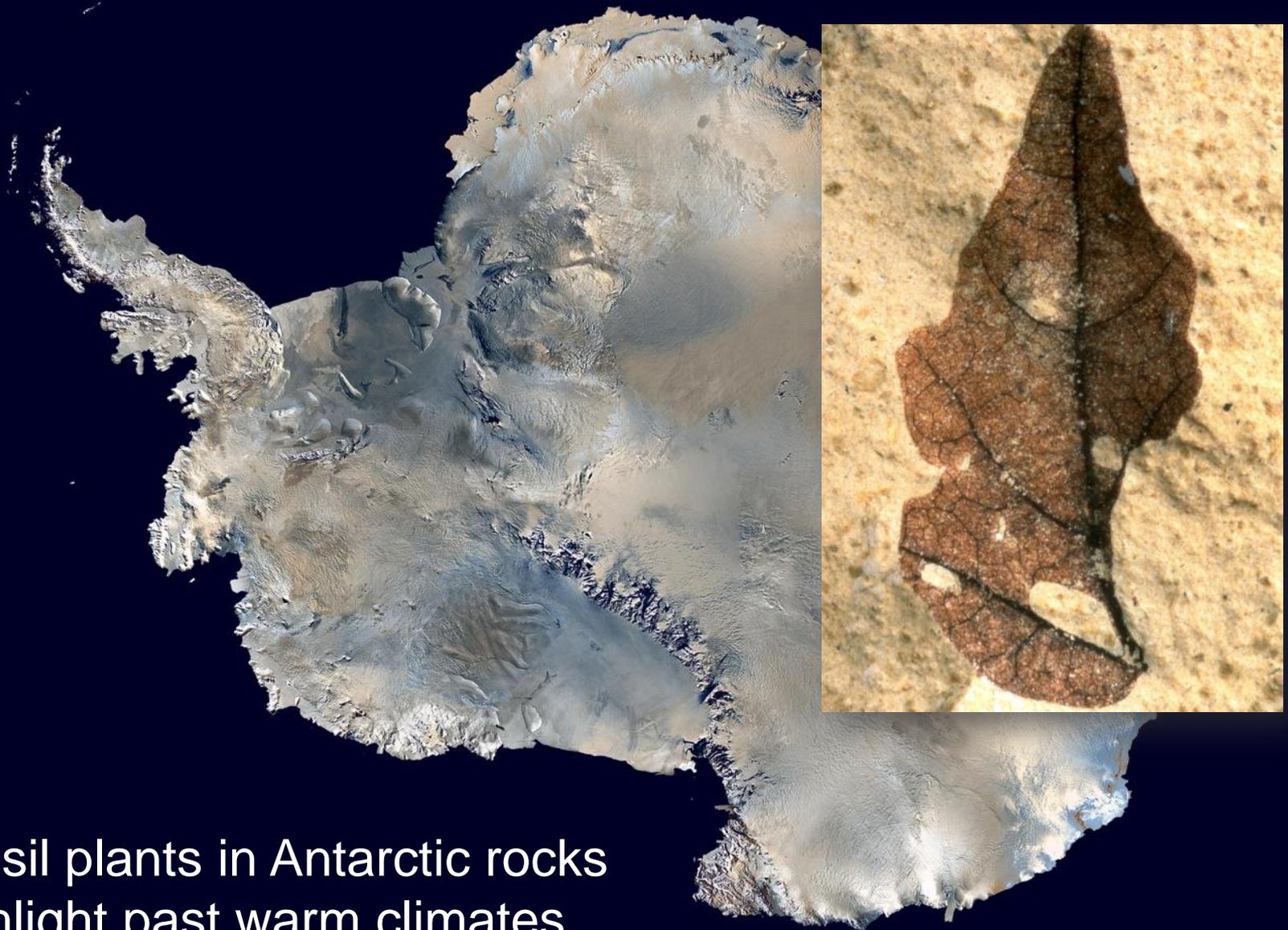


# Pliocene environments on Antarctica from the fossil record



**Jane Francis**  
British Antarctic Survey

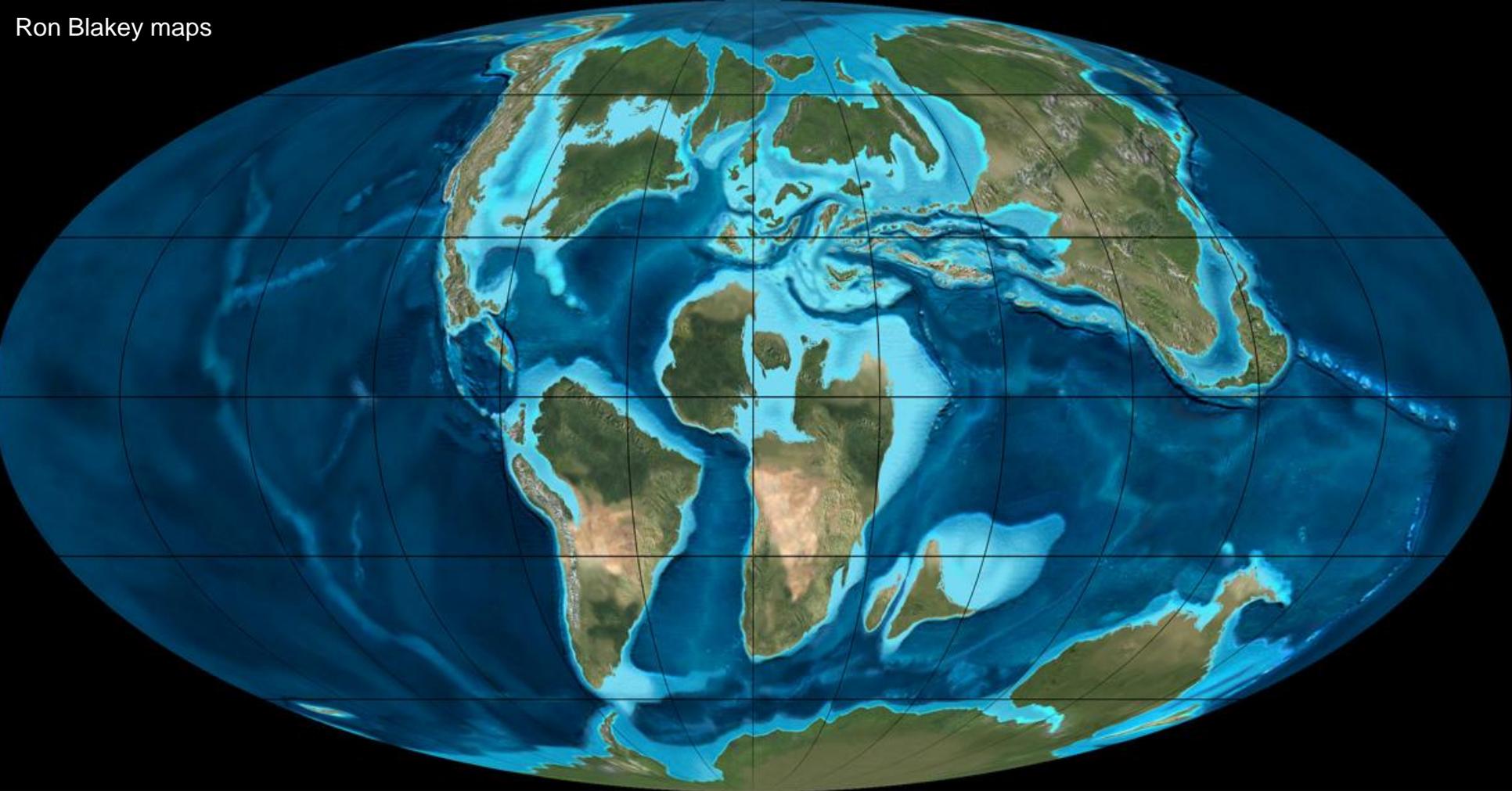


Fossil plants in Antarctic rocks highlight past warm climates

<1% rock but with fossils

# Seymour Island, Antarctica





From 100 million years ago (Cretaceous) the Antarctic continent was over the South Pole.....  
but Antarctica was warm and green

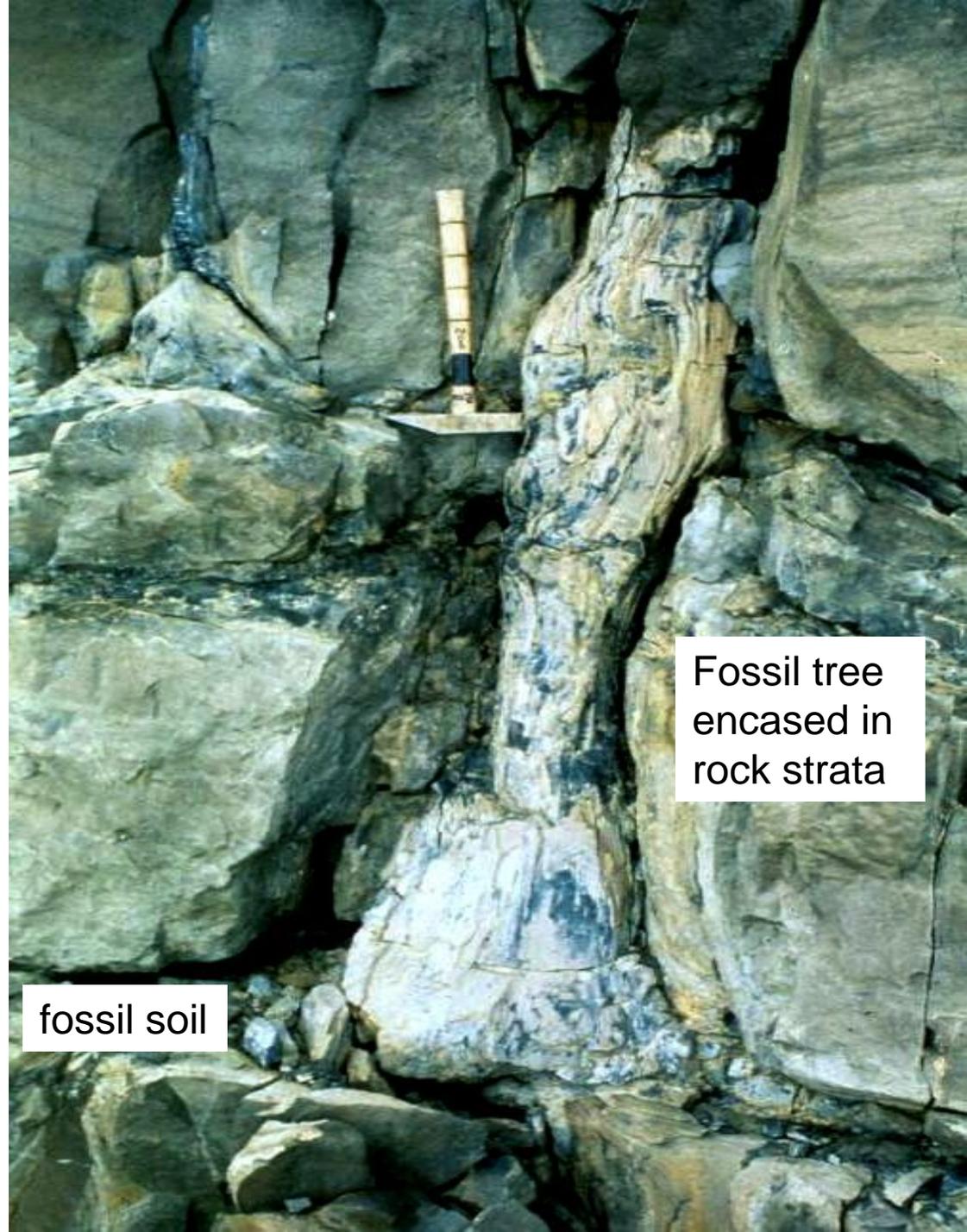
# Cretaceous petrified tree stumps in their original growth position

Alexander Island, Antarctica

petrified tree trunk



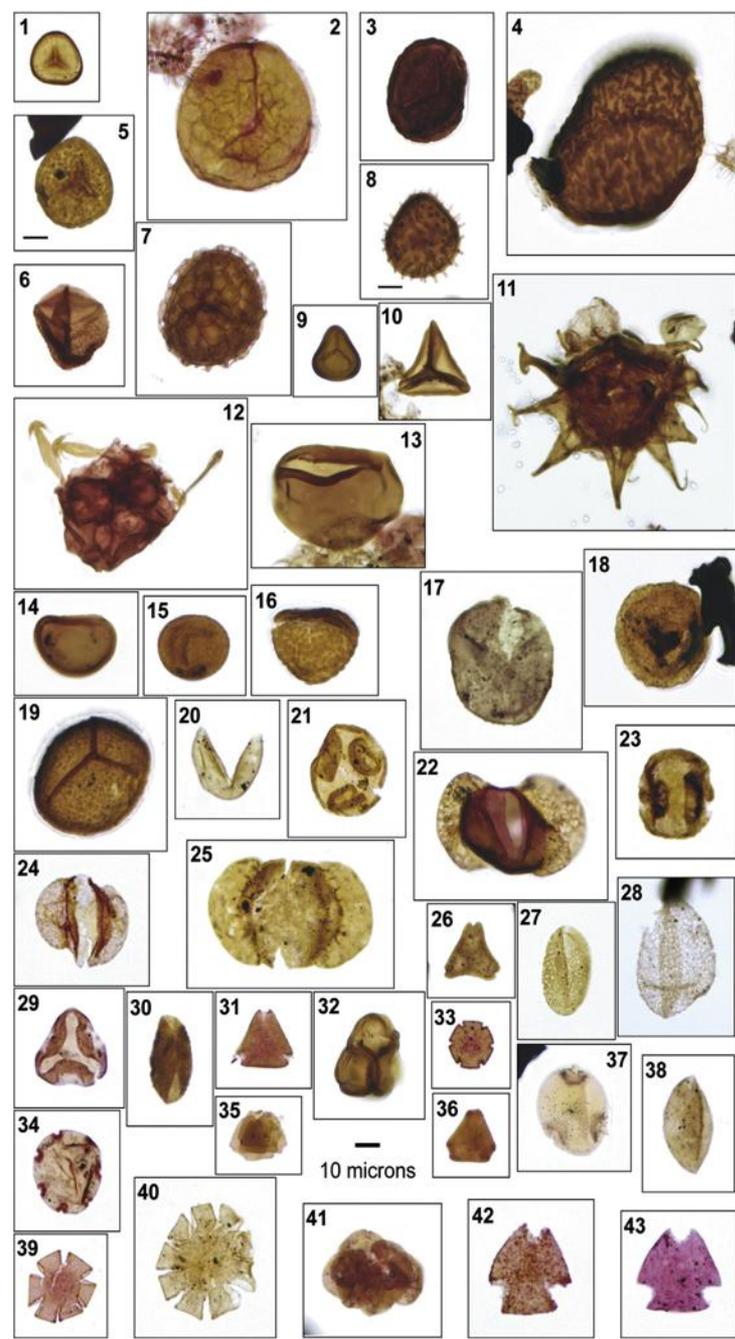
Jodie Howe



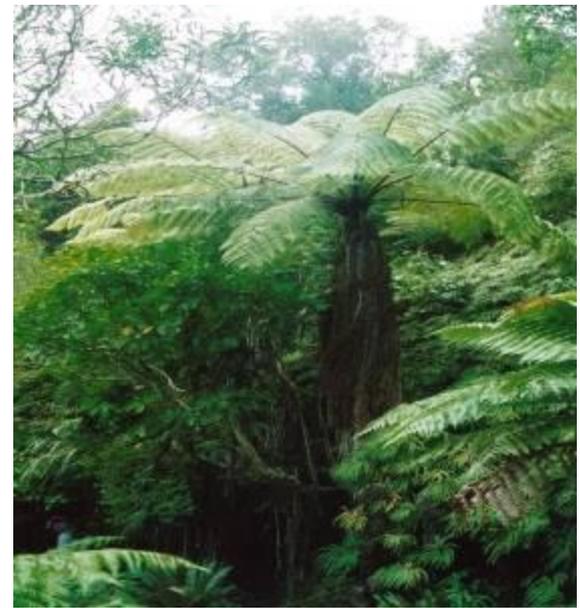
Fossil tree encased in rock strata

fossil soil

# Fossil pollen, fossil leaves and fossil wood



# Ferns



Fossil *Cladophlebis*

*Dicksonia antarctica*

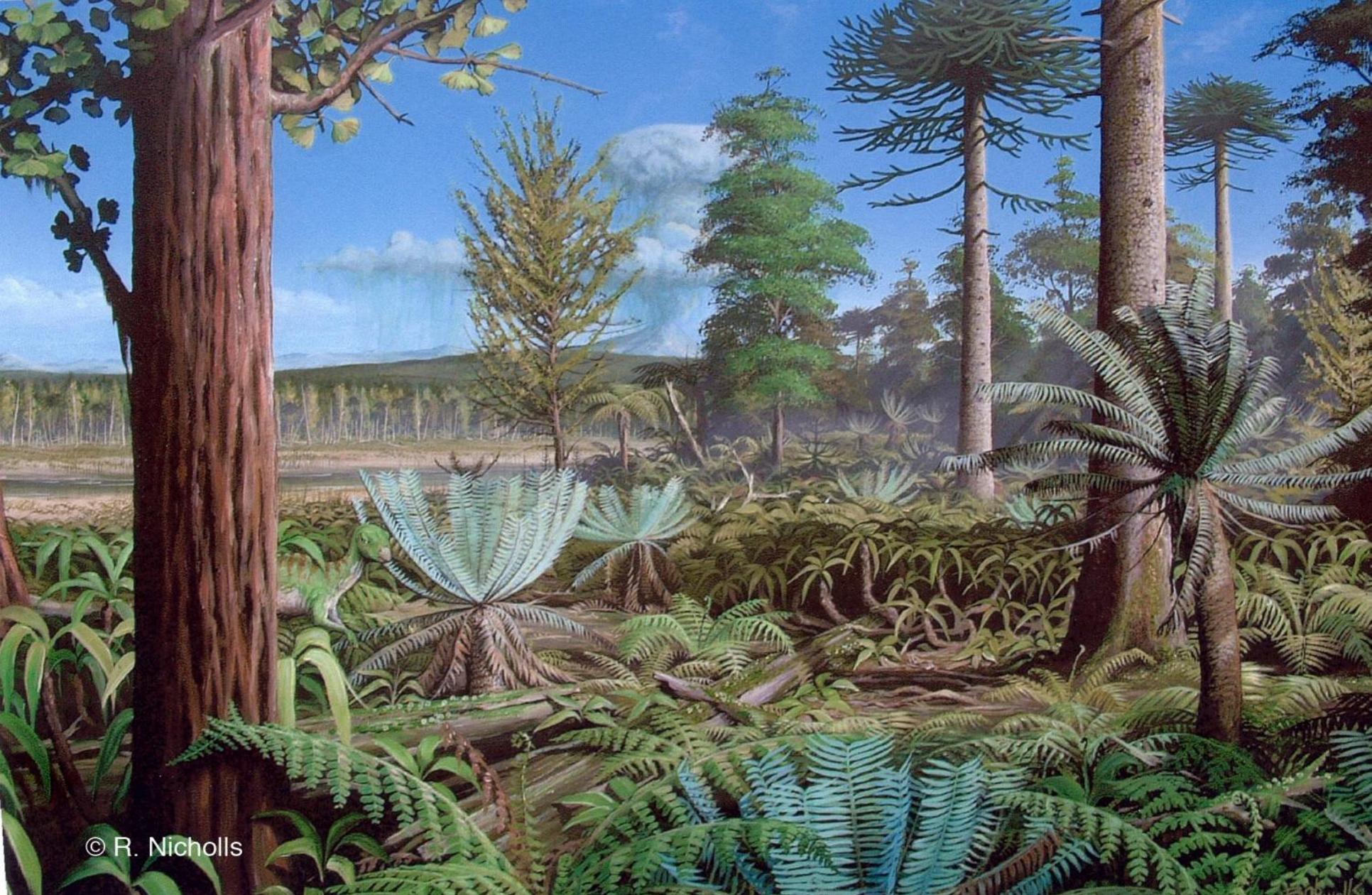
# Monkey Puzzle trees grew in Antarctica



*Araucaria  
araucana*



*Araucaria araucana*, Monkey Puzzle,  
growing today in the Chilean Andes



© R. Nicholls

## 100 million year old forests, Alexander Island

Based on PhD work of Jodie Howe & Jane Francis, University of Leeds and BAS geologists. Painted by Rob Nicholls. Housed at BAS

Many Antarctic fossil plants are related to plants that live today in South America, Australia and New Zealand - ancient ancestors of Southern Hemisphere vegetation under warm climates



*Nothofagus*  
Cool temp

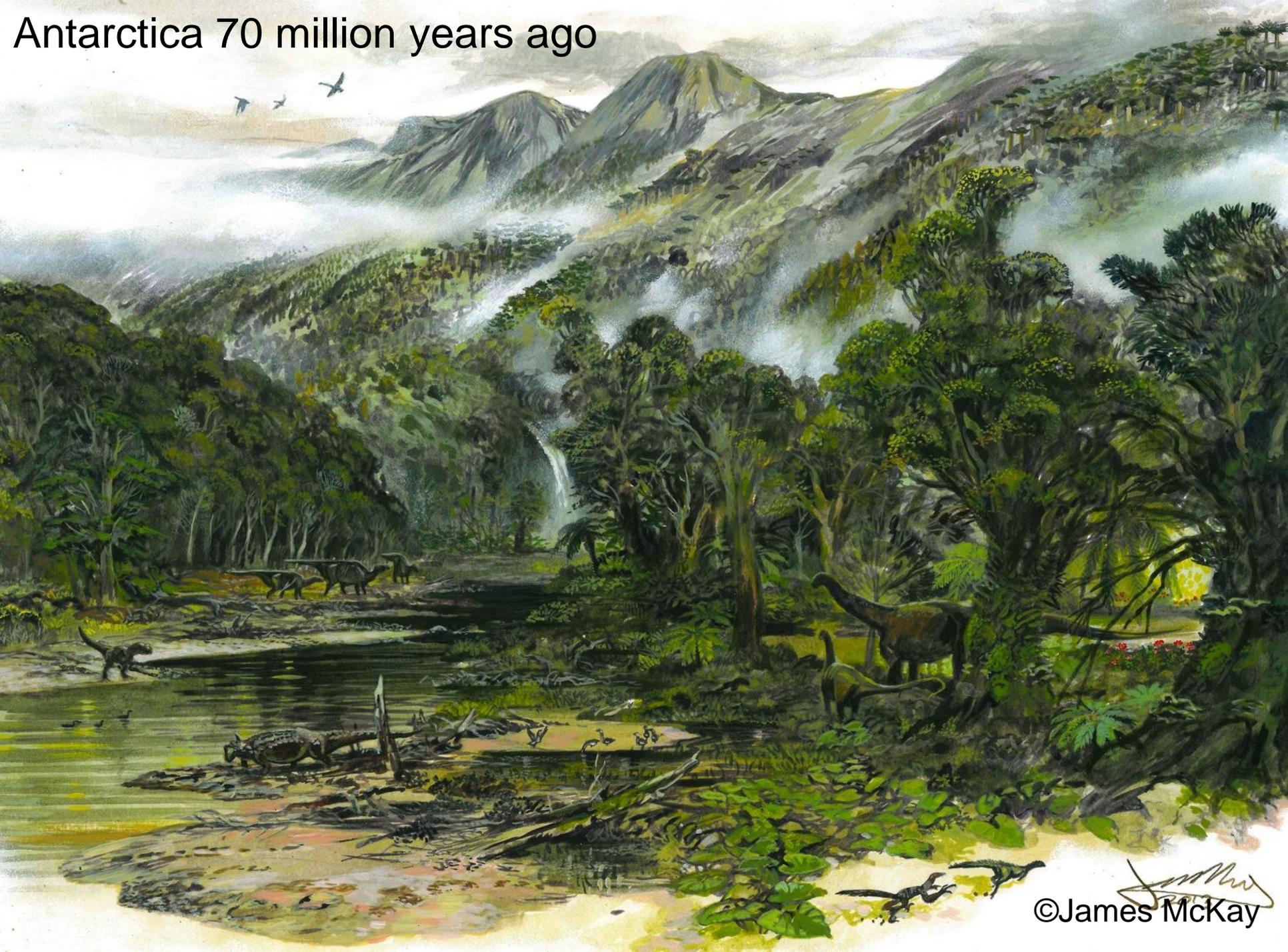


*Embothrium*  
Warm temp



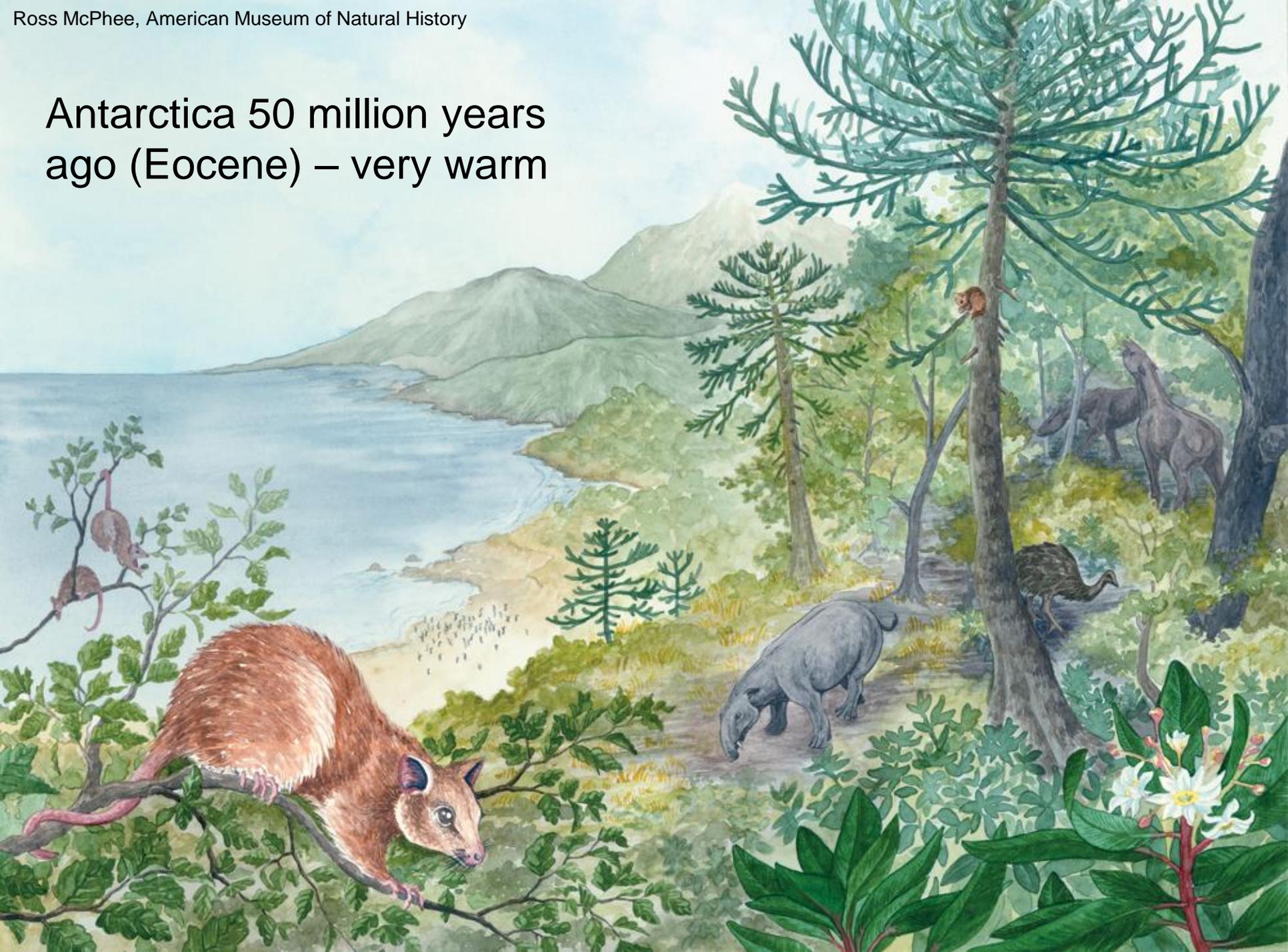
*Brachychiton*  
Sub-tropical

Antarctica 70 million years ago



*James McKay*  
©James McKay

# Antarctica 50 million years ago (Eocene) – very warm



Cooler climates allowed ice sheets to form  
and glaciers reached the coast by 40  
million years ago



Reconstruction of Miocene ice sheet, Antarctica. 14-23 my

Gasson et al. 2016 PNAS v113. [www.umass.edu](http://www.umass.edu)



## Beardmore glacier

40km wide

40 million years ago the climate changed and glaciers covered Antarctica – but the forests survived, even in the cold climate



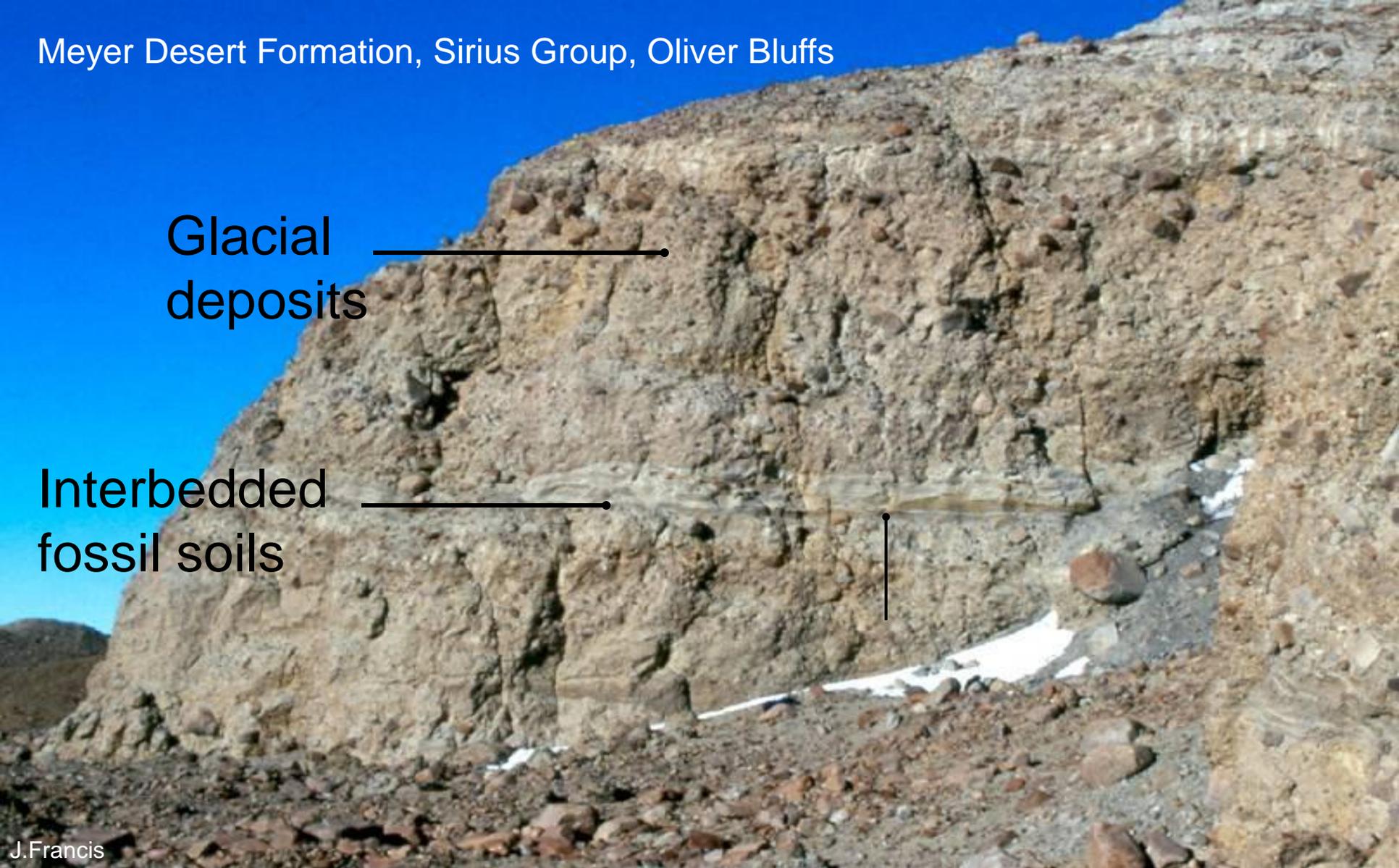
Only 300 miles from the South Pole at Oliver Bluffs.....



Meyer Desert Formation, Sirius Group, Oliver Bluffs

Glacial deposits

Interbedded fossil soils



J.Francis

The last place you would ever look for fossil plants – in a glacial tillite!



Tiny mummified twigs



Living Arctic dwarf tree

J.Francis

Small woody shrubs rooted in immature soils, with branches hugging the ground surface and twisting around boulders





J.Francis

Leaf mat of 12 million year old fossil leaves  
*Nothofagus beardmorensis* (southern beech)



Modern analogue for Sirius  
environments in Antarctica - Axel  
Heiberg, Canadian High Arctic

Mean annual temperature  $-12^{\circ}$  C



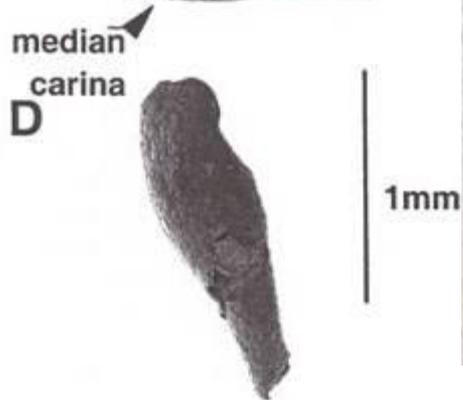
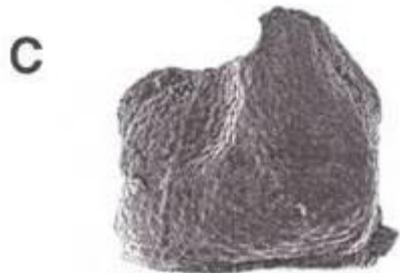
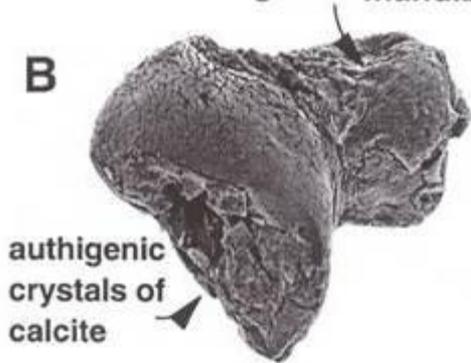
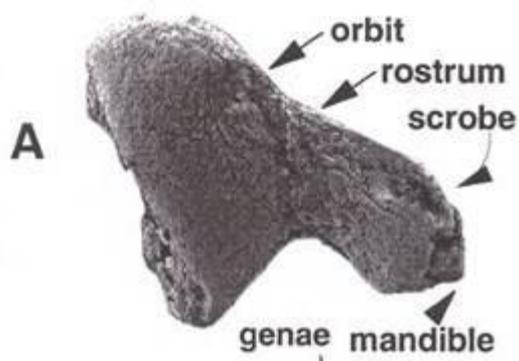


Ashworth & Cantrill 2004



Antarctic fossil cushion plant

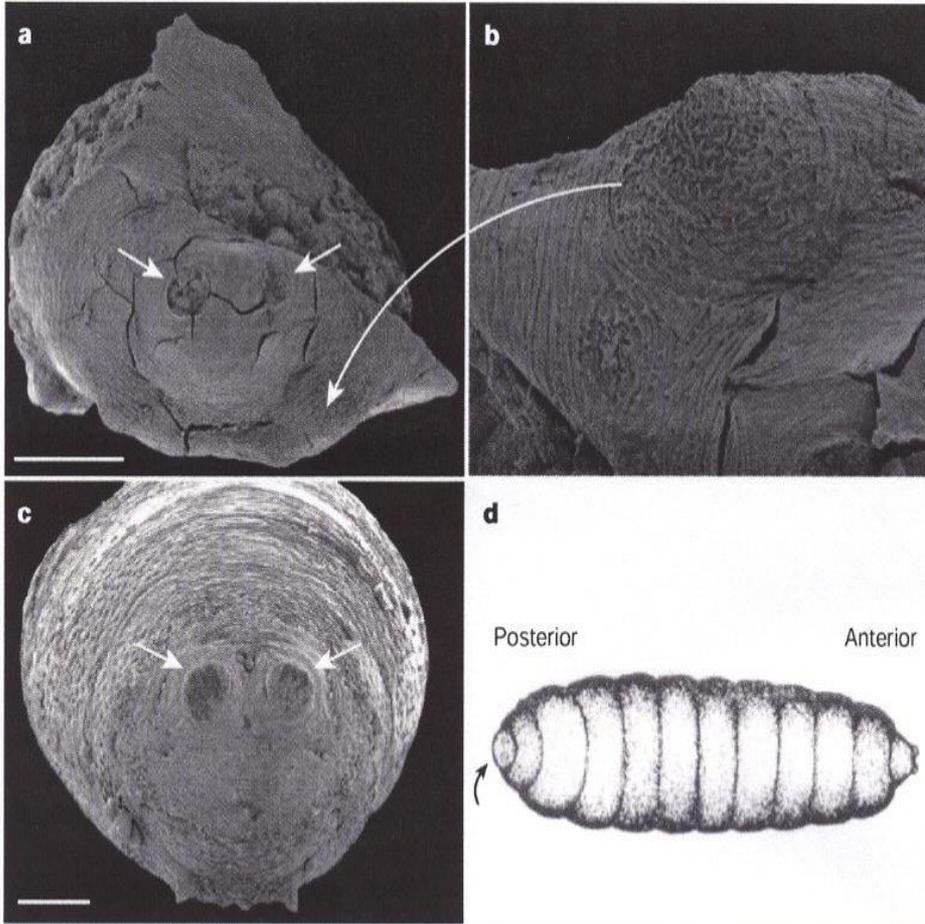
Mountain tundra  
landscape, Tasmania



Allan Ashworth

Amazing finds of  
fossil weevils

# Fossil fly puparium (maggot case)





- Fossil biomarkers (e.g. alkenones, lipids) from the fossil plants indicate the presence of angiosperms (flowering trees), mosses, sedges, bryophytes, algae
- Mosaic of bogs, herbs, shrubs and tundra plants
- Terpene palaeothermometers suggest summer temperatures of 3 – 5°C

Antarctica  
future?