Exploring Antarctica's Biological History

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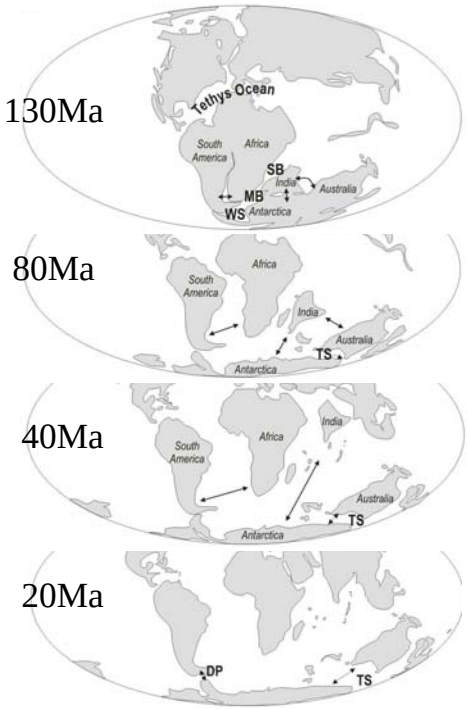
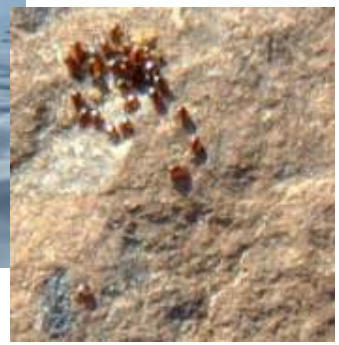
Antarctic Biological History

- Talk will explore Antarctic terrestrial biological history, and some implications
- Climate change in Antarctica is nothing new
- Remnant of Gondwana, last connection to S. America lost c. 30-50 mya
- First glaciers at least 34 mya, eventually leading to continental icecap
- Prior to substantial ice coverage, Antarctica supported a diverse temperate assemblage of plants and animals
- Tundra-like fauna and flora survived after isolation and even to 5-2 mya, then wiped out



Glacial Maxima

- Past glaciation had a pervasive influence on terrestrial ecosystems
- At LGM, continental ice cap and ice shelves extended to shelf break (Peninsula), plus even thicker than present
- Previous maxima in Miocene, Dry Valleys partly ice free since
- Low altitude land covered and scoured, though nunatak refuges may have remained (not relevant to most biota)
- Glaciation may have driven biological radiation both in the sea and on land; over what timescale?



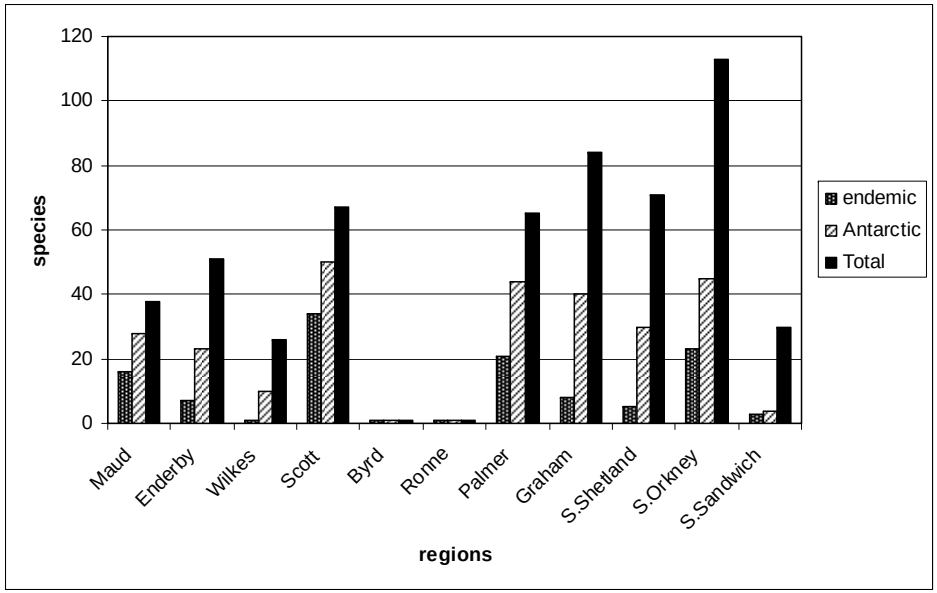
Classical view of LGM and before

- Ice sheets deeper and more extensive than now, to shelf edge around Peninsula and Scotia Arc island groups, and much of continent
- Accepted view that low altitude (coastal) ice free ground over-run, and no replacement rocky coastline; however, precise boundaries of reconstructions poorly defined, debate on ice sheets stability
- Biology – implies most terrestrial biota should be recent (probably post LGM) colonists, as no available habitat
- Some continental nunatak and Dry Valley (VL) refuges exist, but a separate story with specific fauna, and do not explain most contemporary biota

Antarctic endemism

- Feature of many terrestrial species, until now not linked across groups
- At least one third of the terrestrial invertebrates and near 50% of lichen species known from Antarctica are endemic
- Levels approach 100% in some groups (e.g. nematodes)
- Also little or no commonality between Peninsula and continent

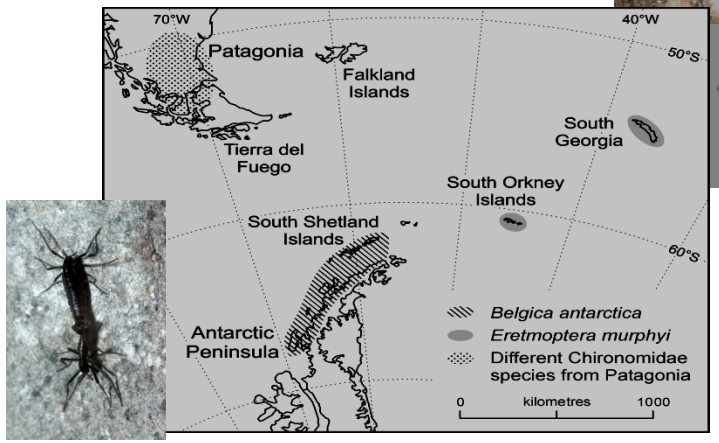
Biogeographic region	species	% of total	
Endemic – Continental Antarctica	77	25.5	58.6
Endemic – Maritime Antarctica	92	30.5	
Endemic – Pan-Antarctic	8	2.6	
+ sub-Antarctic islands	44	14.6	41.4
+ Gondwana/ cosmopolitan	81	26.8	
TOTAL	302		

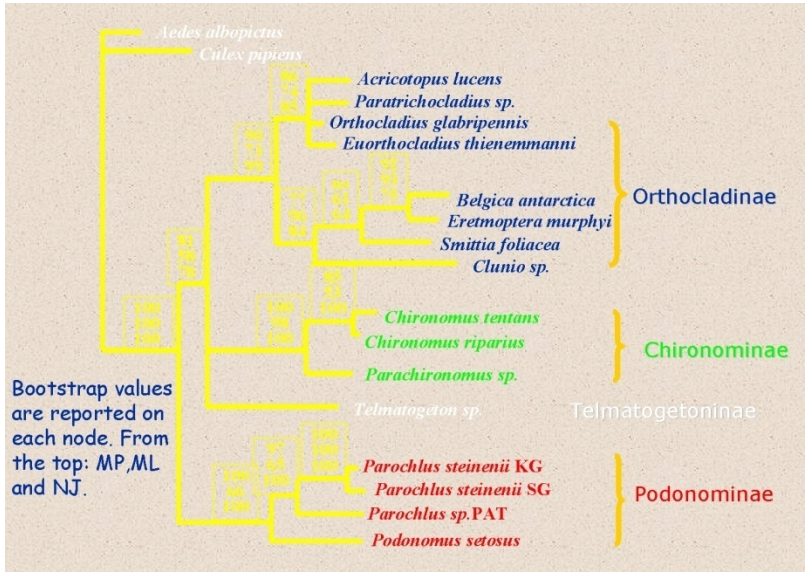


Pugh & Convey (2008) J. Biogeog.

Molecular Phylogeny

- "Molecular clock" approach can date evolutionary separation events
- Applied to Antarctic Peninsula and South Georgia chironomids, endemic on separate tectonic elements
- Generates divergence dates c. 49 mya
- Possibly coincident with geological separation of Antarctic elements, certainly not Pleistocene retreat

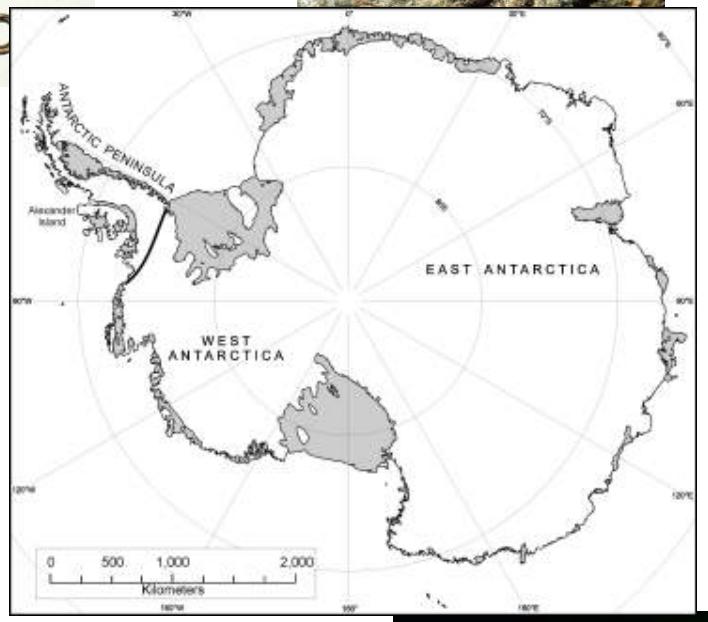




Allegruci *et al.* 2006, Polar Biol

Large-scale Biodiversity Patterns – a Shifting Paradigm

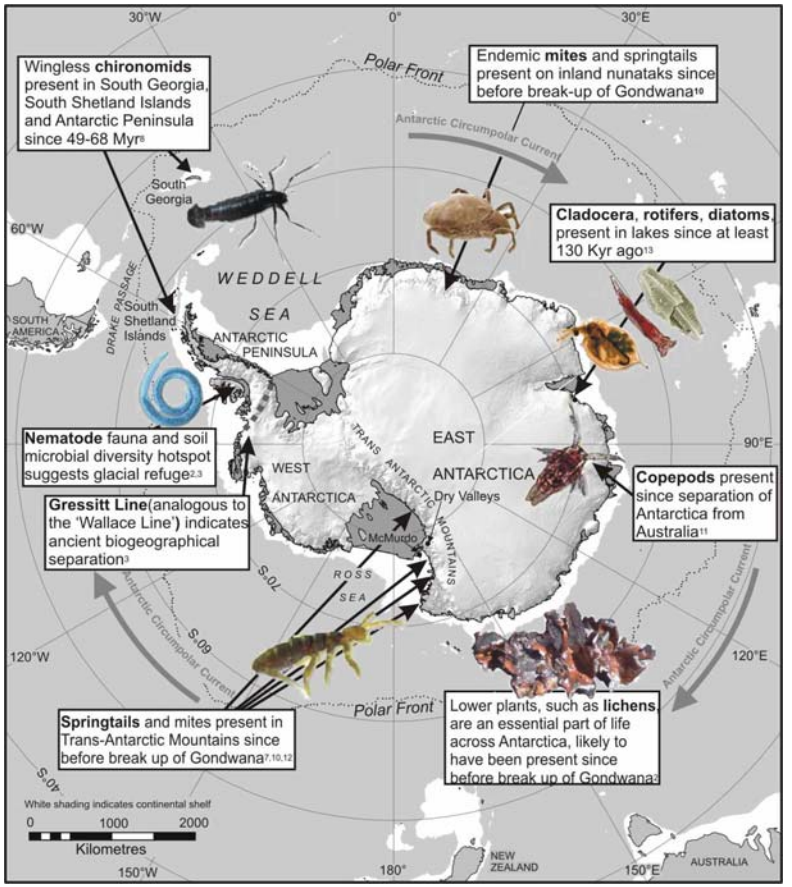
- Patterns do not support view of recent (post Pleistocene) dispersal
- Little or no species overlap between maritime and continental Antarctic in springtails, mites, nematodes
- More regionalisation than previously thought
- At continental scale, Antarctic "Wallace Line" evident for many invertebrate groups



Barnes et al. 2006 Glob. Ecol. Biogeog.; Chown & Convey 2007, Phil. Trans. Roy. Soc.

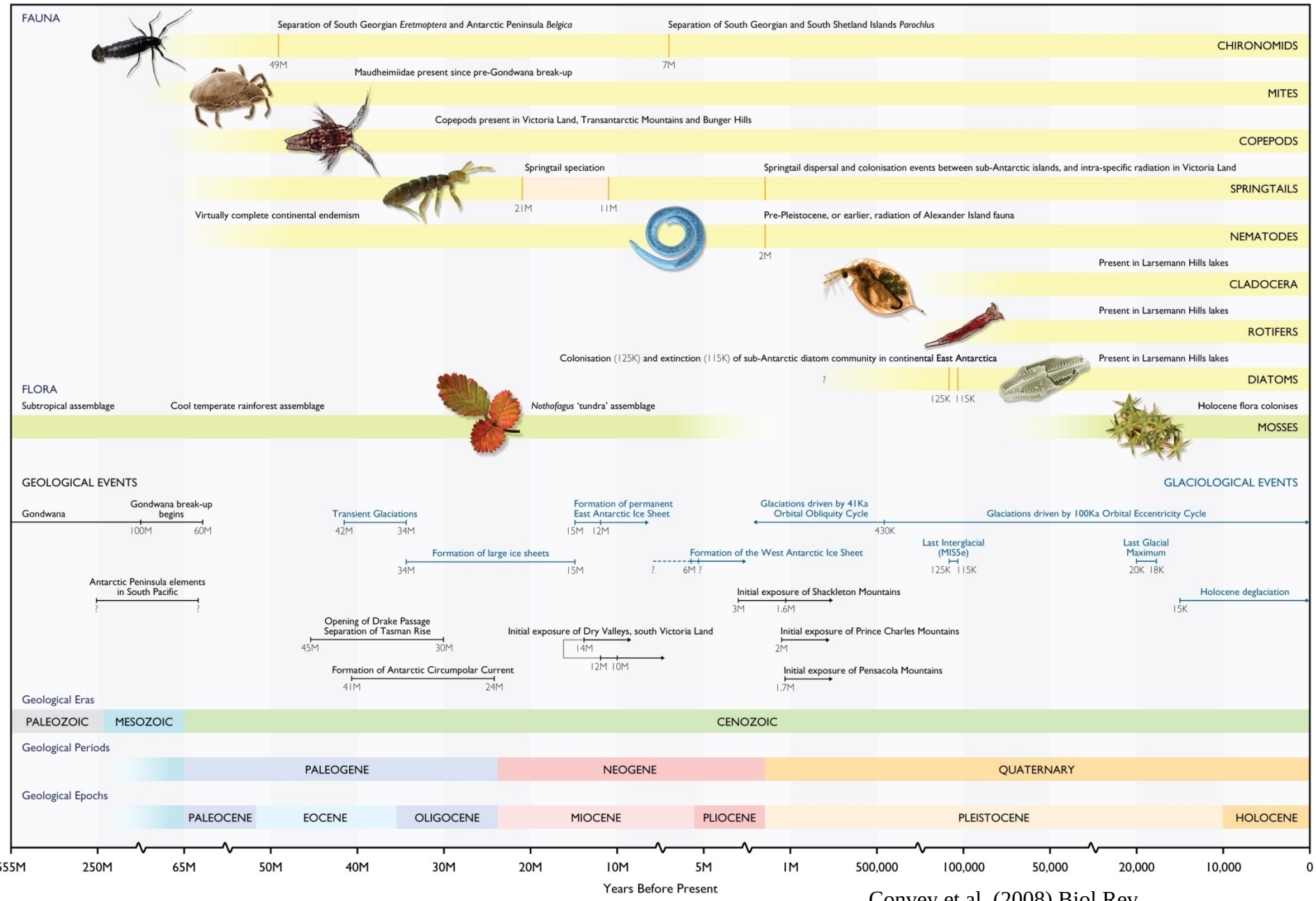
Biotic Persistence

- Examples of 'ancient' persistence now inferred from most contemporary biotic groups, most regions of the continent, and all timescales from pre-LGM to pre-Gondwana-breakup
- Nunatak refugia are plausible, if geologically unproven, for minority
- Low altitude biota (majority) present an unresolved challenge to current glacial reconstruction
- In principle, can be used as a proxy to constrain extent or thickness of icesheets



Convey & Stevens (2007) Science

BIOLOGICAL COLONISATIONS AND EXTINCTIONS IN ANTARCTICA (Inferred Biogeographic Molecular Phylogenetic and Fossil Evidence)



Convey et al. (2008) Biol Rev

Conclusions

- Increasing terrestrial biological data, across taxa and across the continent, challenge current ice sheet paradigm
- Reconciling biological advances and glaciology requires a paradigm shift in our views on the evolution of Antarctica
- Biological data should be recognised as a novel constraint in ice sheet reconstruction
- Long term presence also provides opportunity to examine evolution within Antarctica

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Thank you for your attention!