

Tectonics and genetics in topographic evolution

Hochstetter Lecture 2017

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in collaboration with:
 Profs Jon Waters, Graham Wallis, Zoology Dept, OU
 Dr Phaedra Upton, GNS Science, Lower Hutt
 Dr Chris Burridge, Zoology Dept, Univ of Tasmania

Richard Norris (1945-2016)
Mentor, colleague, friend for 40 years

Ferdinand von Hochstetter (1829-1884)
German-Austrian pioneer geologist
Auckland, Nelson 1858-59

Acknowledgements in memoriam

Dun Mountain, NZ

Hochstetter arms (from Gregor Macaulay)

Dunite

South Island topography: 20 million years of geomorphic evolution

Little on-land evidence of this long history

Alpine Fault

Geological record:

- Sediments** (sparse, large time gaps)
- Fission tracks etc** (regional rock uplift, not topography)
- OSL, ¹⁰Be dating** (local points, not whole catchments)

www.geographx.co.nz

How do we determine the history of ranges and valleys when most of the record is continually removed by erosion?

Marlborough

Otago

Structure of talk

Background to fish biological memory

- River capture and fish genetics, and molecular clock
 - Middle Pleistocene tectonic example: Otago/Southland
 - Late Pleistocene examples: Marlborough

Using geology and fish genetics to infer topographic evolution

- Rise of Southern Alps and development of eastern drainages
- Significance of inherited crustal structure
- Drainage evolution in Southern Alps during on-going convergence

Larger scale synthesis of geomorphic inferences

- Comparisons of fish to other biota in mountains: onset of glaciation
- Regional topographic evolution in South Island
- Speculations on other mountain belts

1. Galaxiid fish & biological memory in rivers

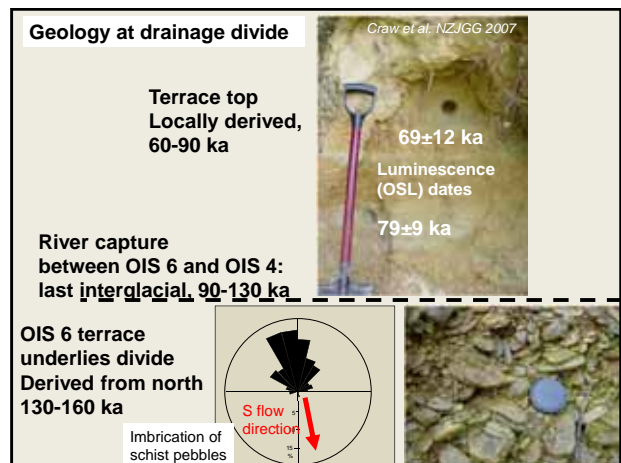
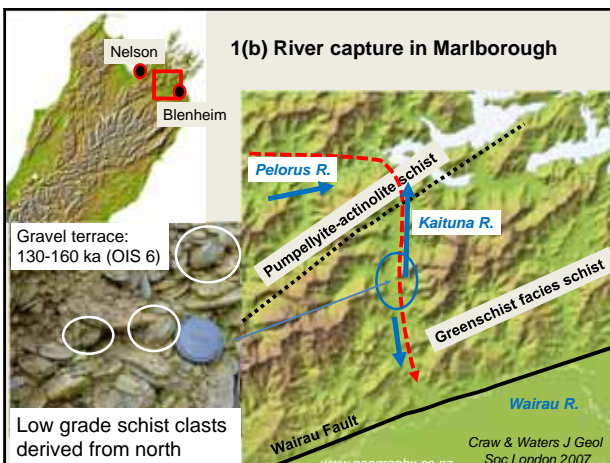
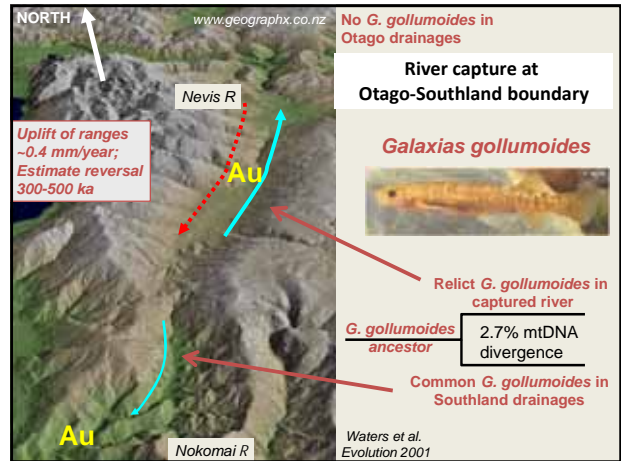
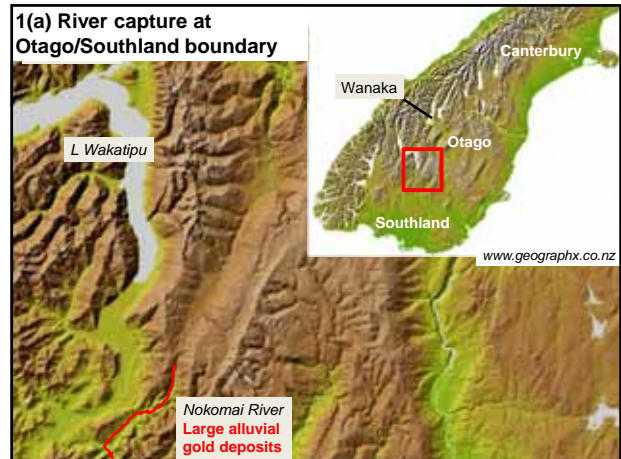
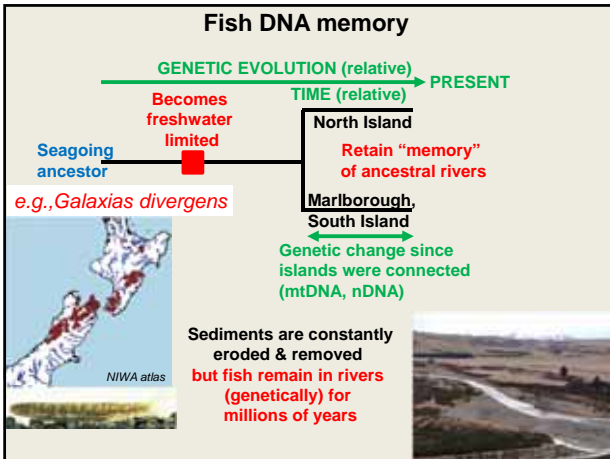
Some species are freshwater-limited
Live entire life in rivers
Common NZ freshwater species:

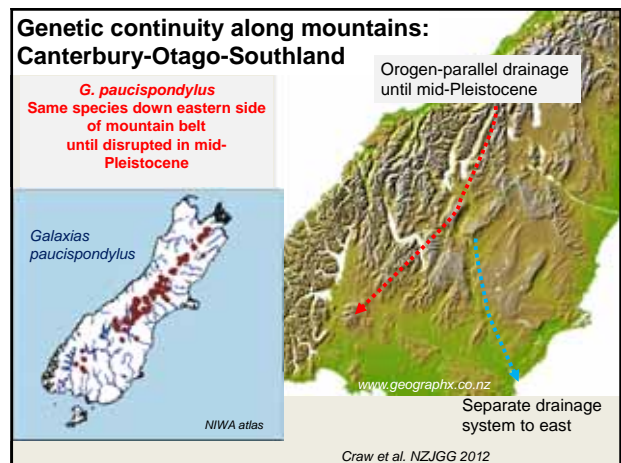
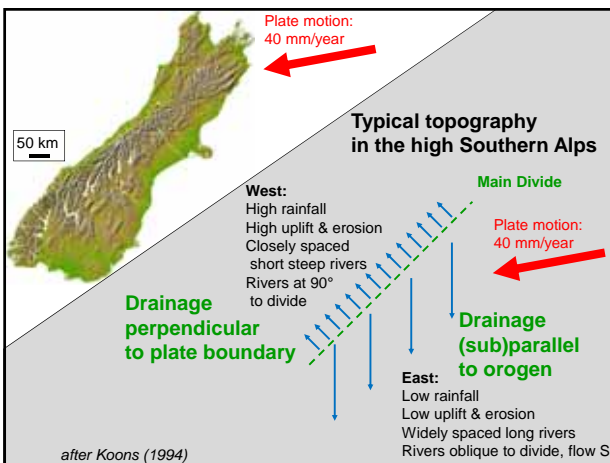
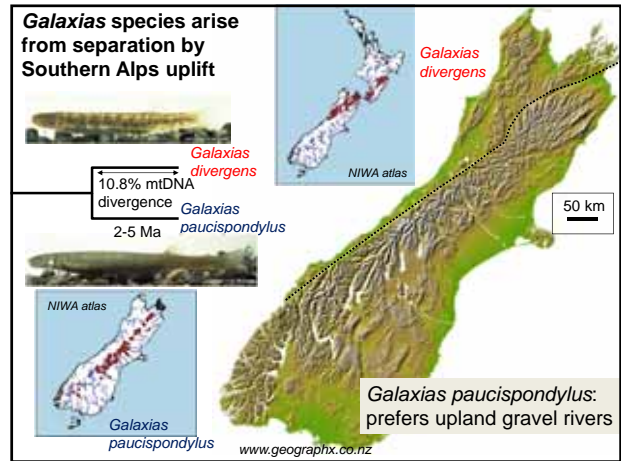
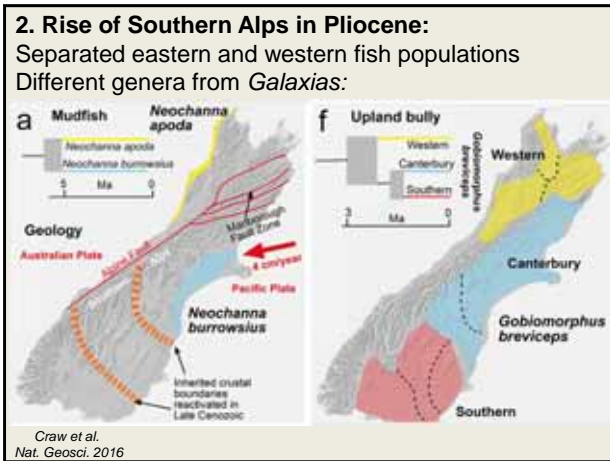
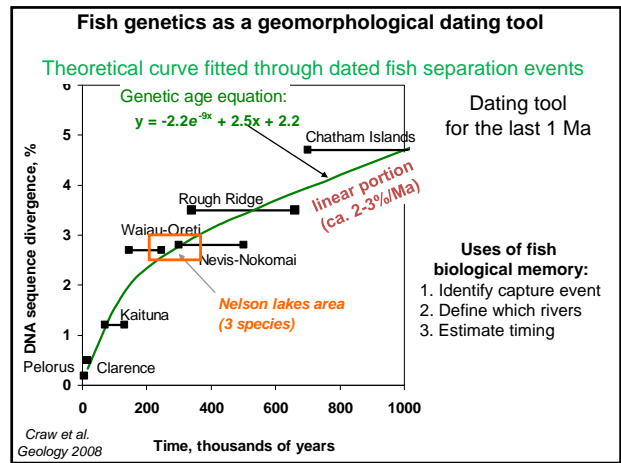
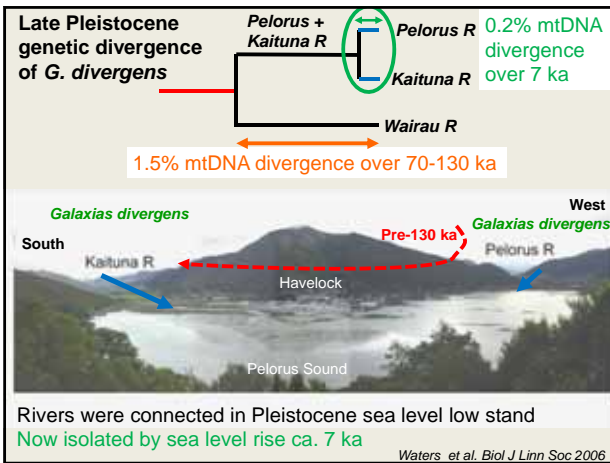
- Flathead galaxiids**
 - G. vulgaris*
 - G. depressiceps*
 - G. teviot*
 - G. divergens*
 - G. paucispindylus*
- Roundhead galaxiids**
 - G. anomalus*
 - G. gollumoides*
- Pencil galaxiids**
 - G. cobitinis*
 - G. prognathus*
 - G. macronasus*

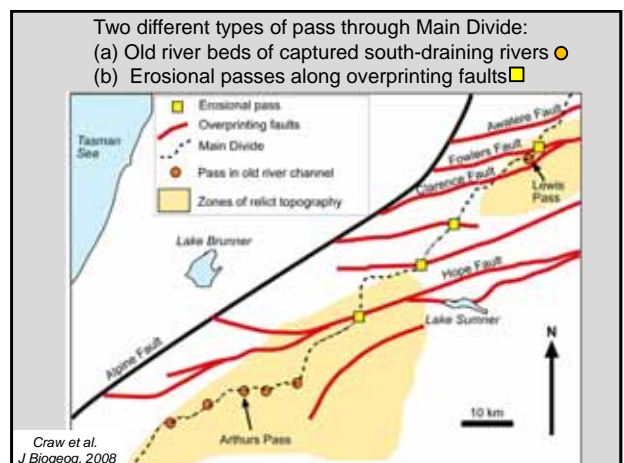
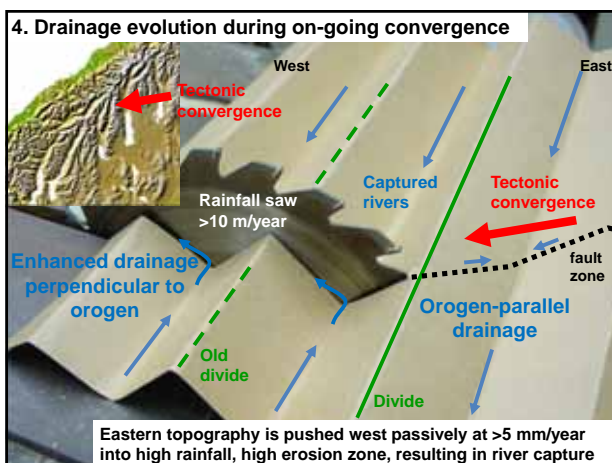
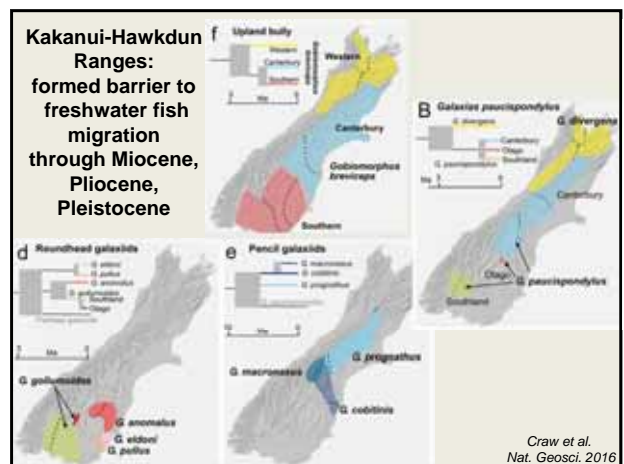
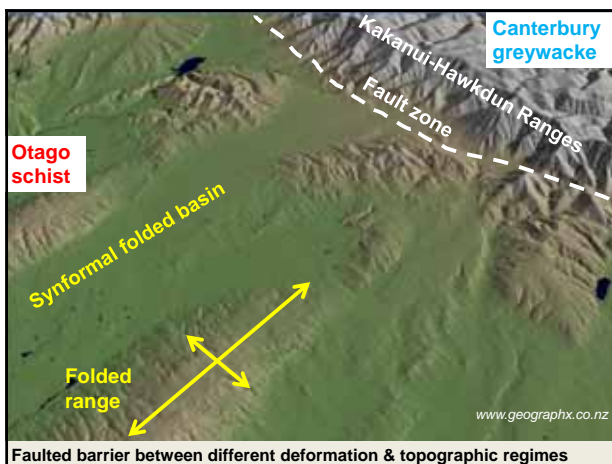
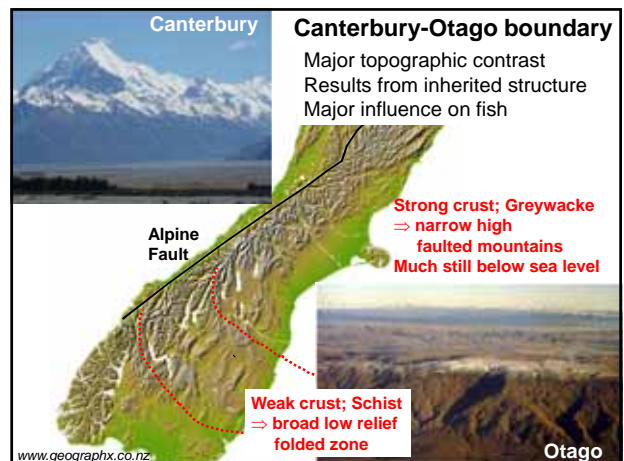
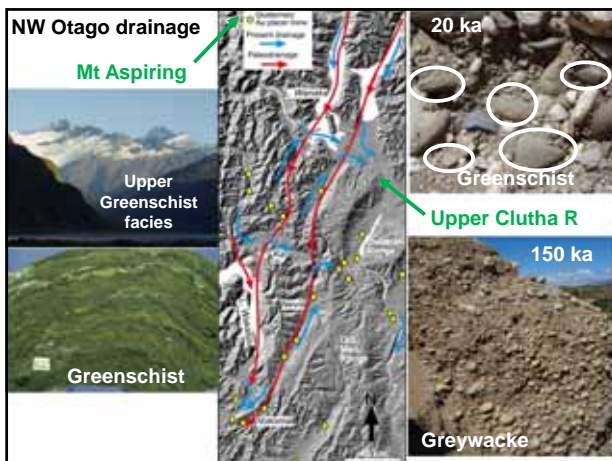
Many species have marine stage "whitebait"

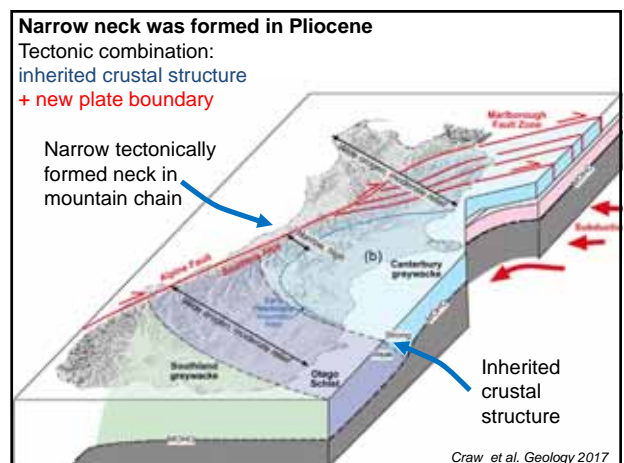
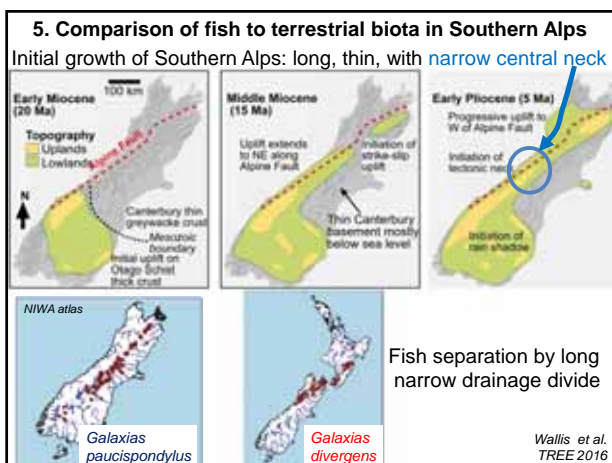
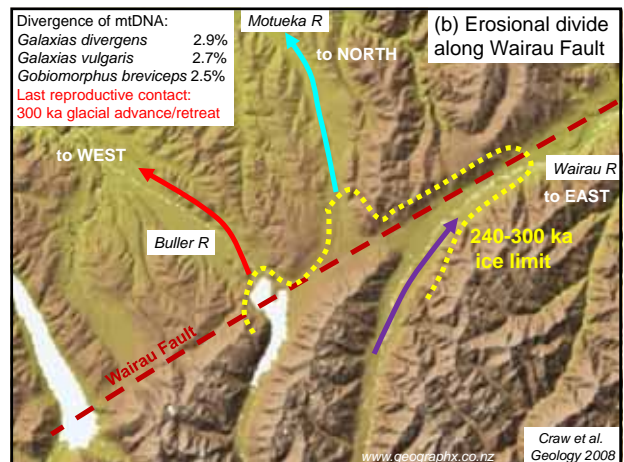
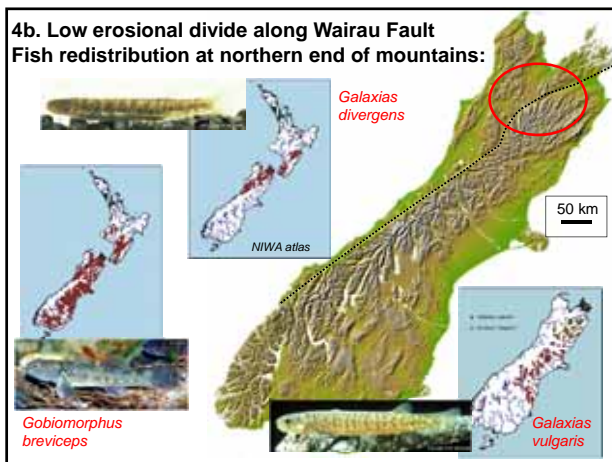
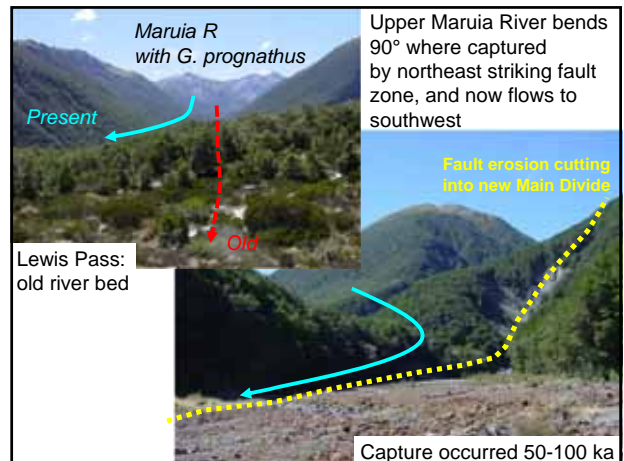
Rivers of fish and gold

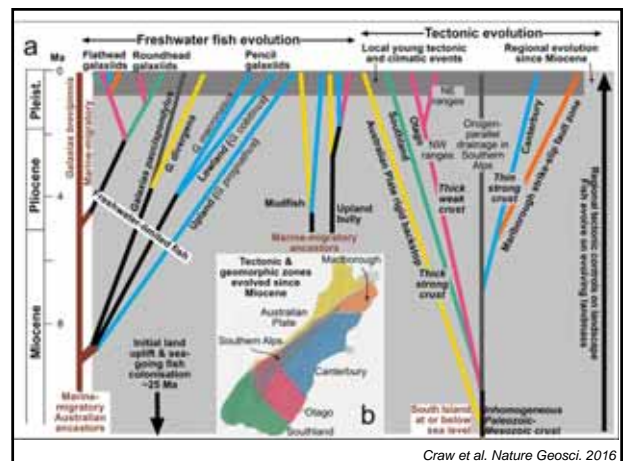
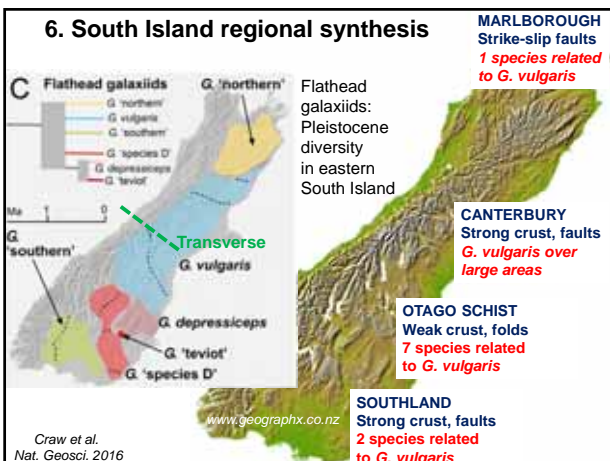
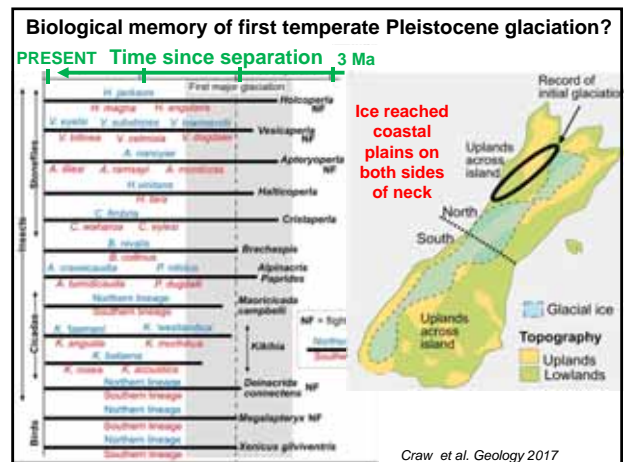
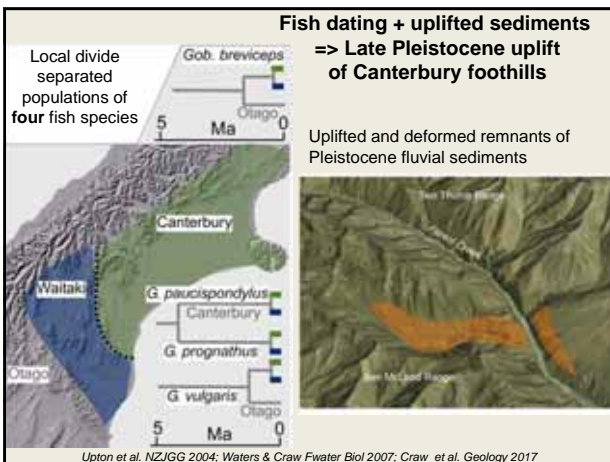
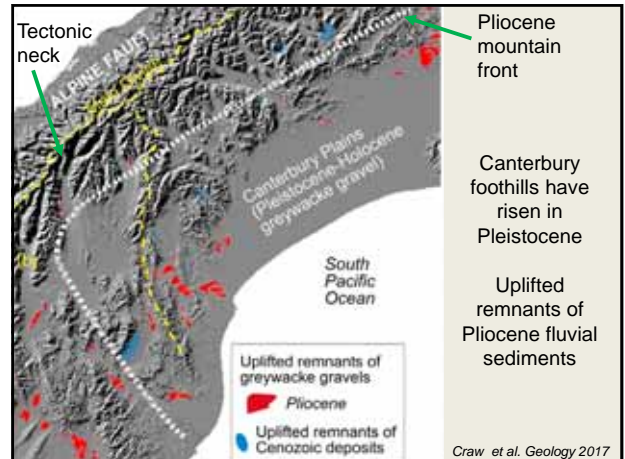
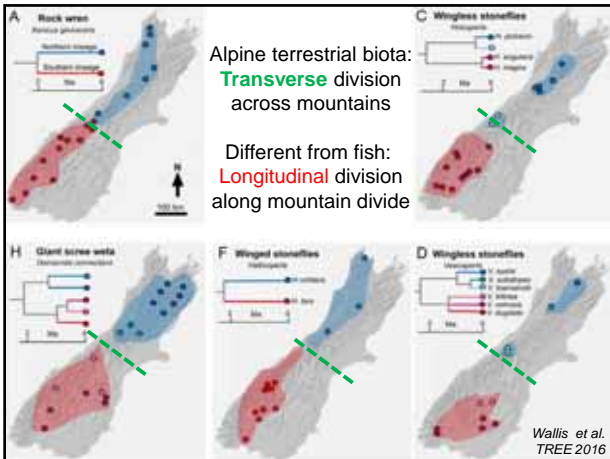
Craw, Min. Dep. 2012

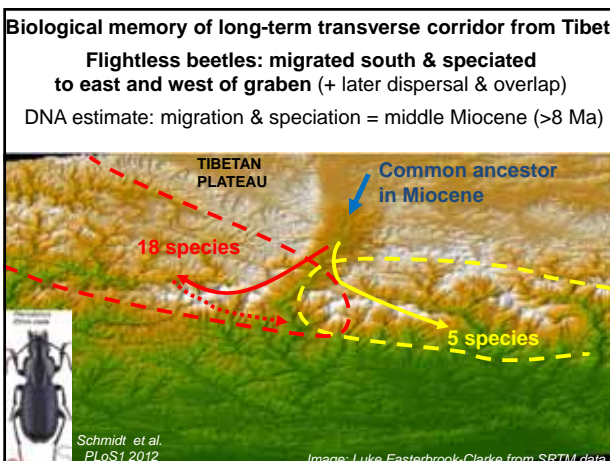
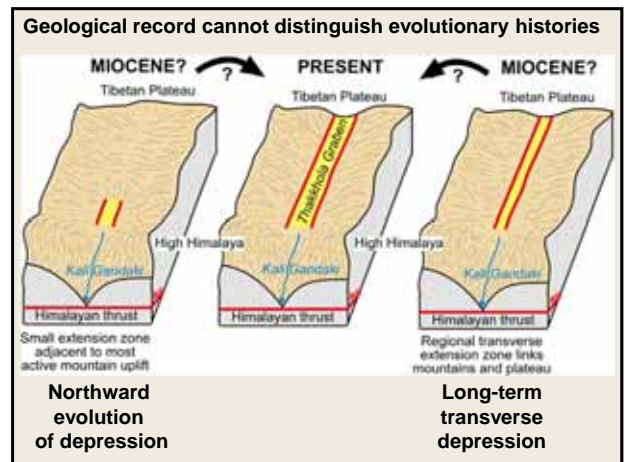
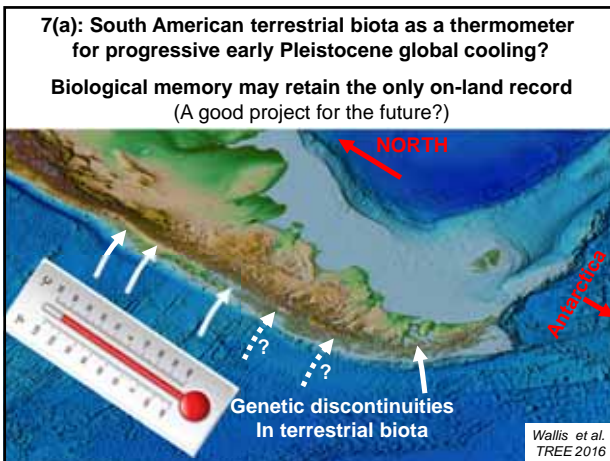












Conclusions

Separate tectonic-geomorphic zones evolved in South Island through Miocene-Recent uplift and evolution of landscape

Freshwater fish populations evolved in varying states of isolation in the separate geomorphic zones

Freshwater fish carry information about the geomorphic evolutionary history in their genes that is difficult to extract from the geological record otherwise

This genetic information can provide evidence for previous drainage connections and severance events, and can estimate timing for these

Alpine terrestrial biota carry an entirely different genetic memory dominated in NZ by the first Pleistocene glaciation, with a prominent transverse discontinuity

Genetic data can augment geological tools, with some limitations (like other tools), for unravelling geomorphological history in mountain belts