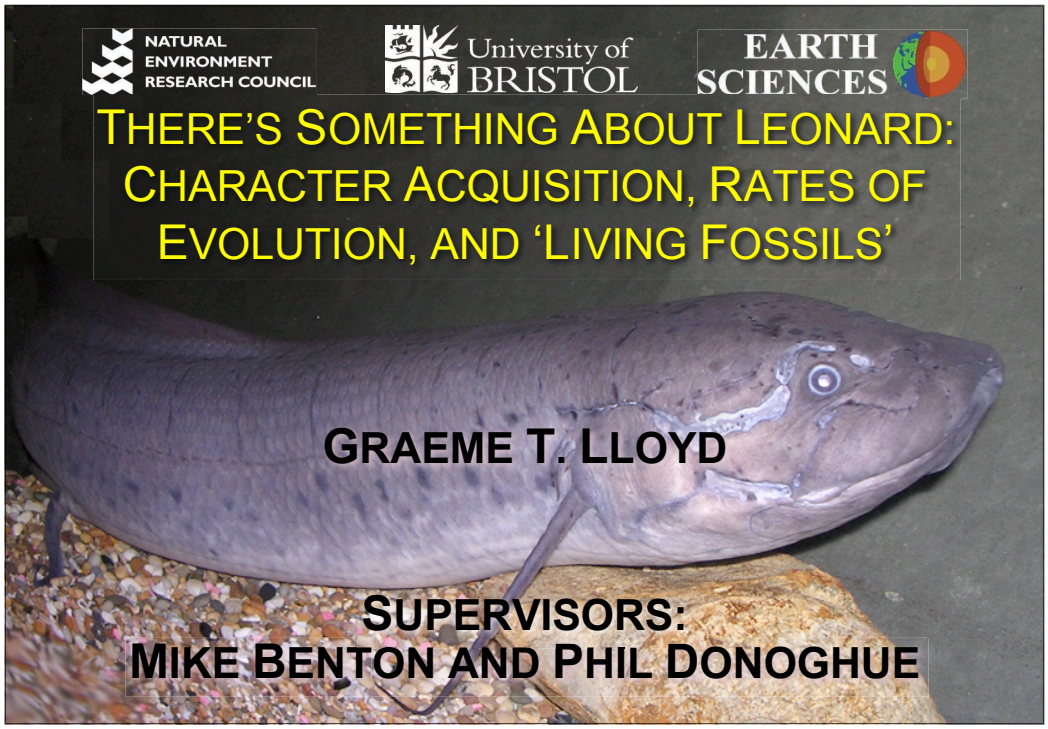
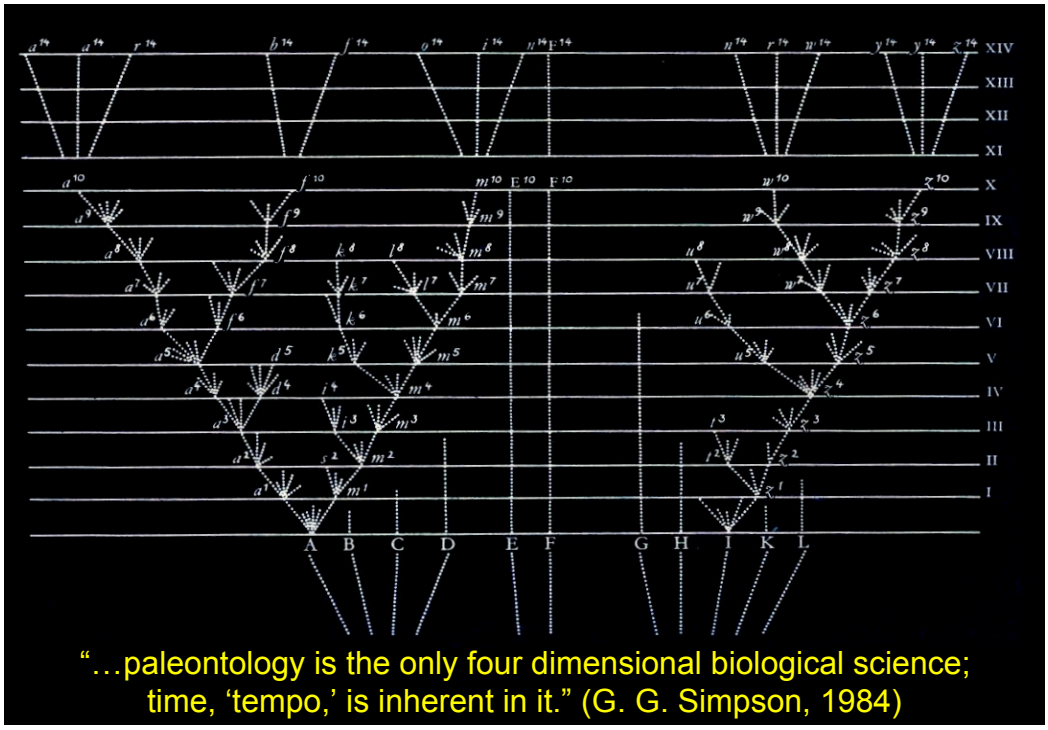

NATURAL ENVIRONMENT RESEARCH COUNCIL
University of BRISTOL
EARTH SCIENCES
THERE'S SOMETHING ABOUT LEONARD: CHARACTER ACQUISITION, RATES OF EVOLUTION, AND 'LIVING FOSSILS'
GRAEME T. LLOYD
SUPERVISORS:
MIKE BENTON AND PHIL DONOGHUE


XIV
XIII
XII
XI
X
IX
VIII
VII
VI
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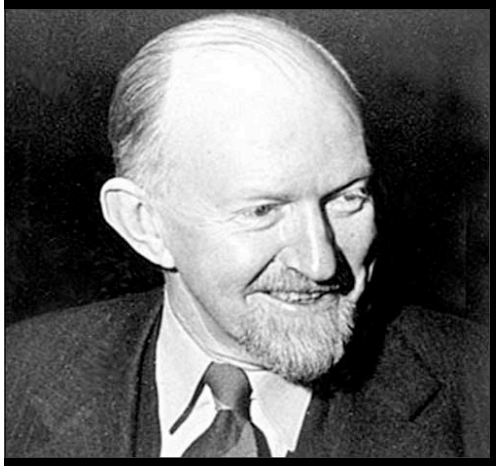
I
A B C D E F G H I K L
"…paleontology is the only four dimensional biological science; time, 'tempo,' is inherent in it." (G. G. Simpson, 1984)

TEMPO AND MODE

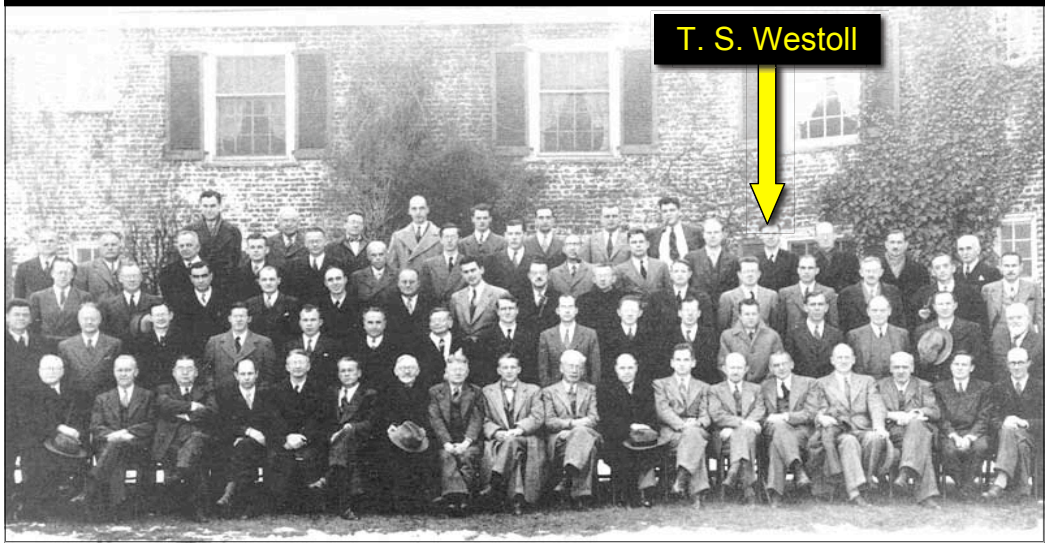


George Gaylord Simpson
1902 - 1984

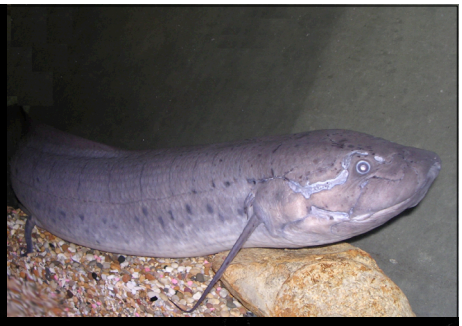
- Simpson published *Tempo and Mode in Evolution* in 1944
- His work concentrated on the evolution of a single character (e.g. hypsodonty in horses, ammonite diameter)
- Three types of rate proposed:
  - Tachytely (fast)
  - Horotely (normal)
  - Bradytely (slow; 'living fossils')

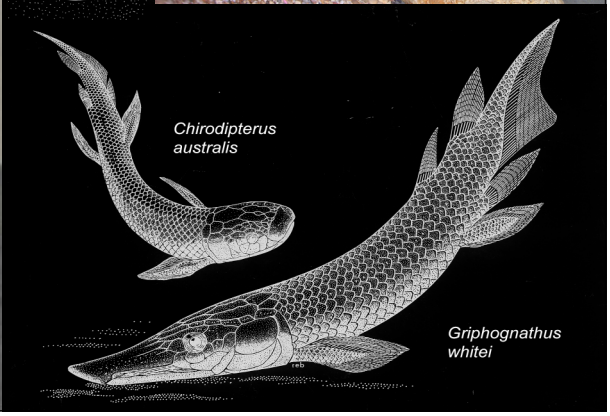
PRINCETON CONFERENCE ON GENETICS, PALEONTOLOGY, AND EVOLUTION

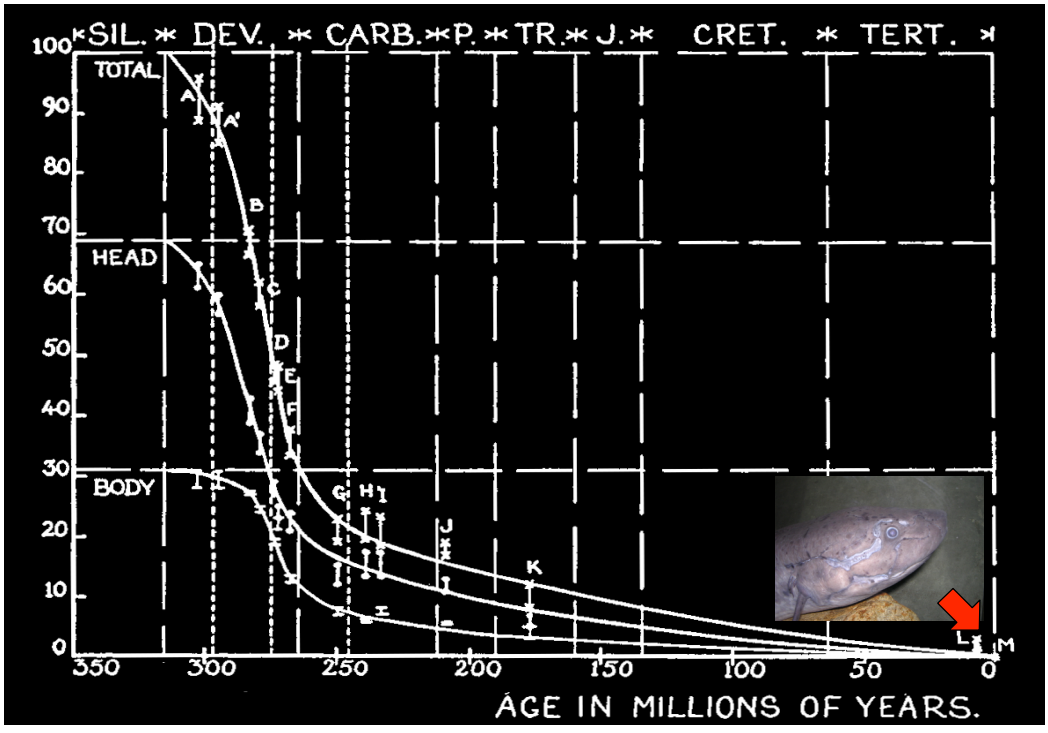
JANUARY 1947



WESTOLL AND LUNGFISH







PROBLEMS OF THE WESTOLL METHOD

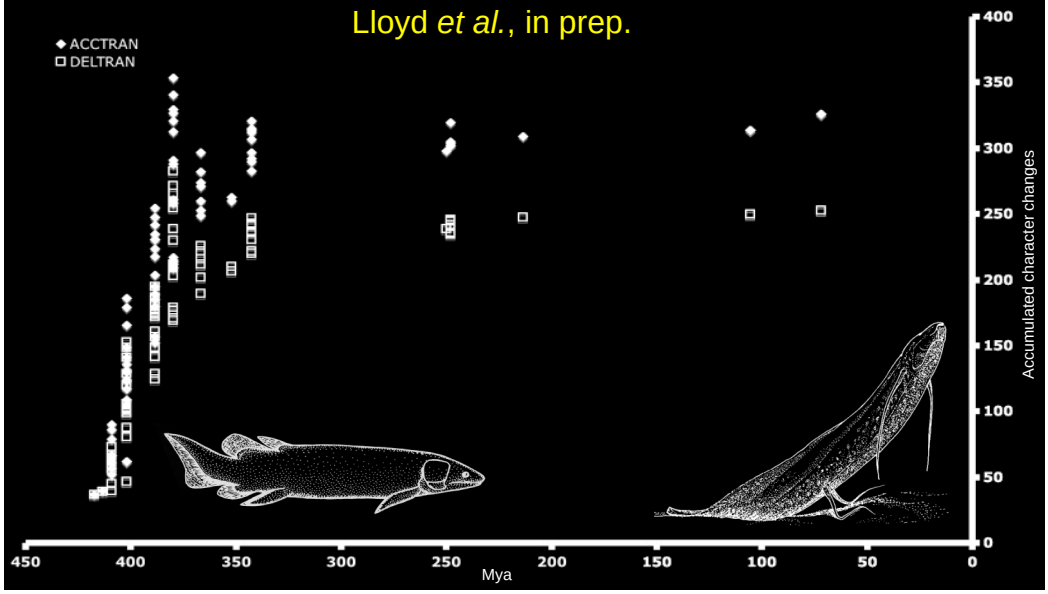
- Ancestor artificial
- Selective suite of taxa
- Missing data (error bars)
- Assumes ancestor-descendant series
- Reversals not taken into account

THE PHYLOGENETIC SOLUTION

- Eight lungfish character-taxon matrices were taken from the literature and combined in a ‘supermatrix’ (88 taxa, 250 characters)
- A phylogenetic hypothesis (tree) was then derived
- Ancestral states along branches of tree are fully resolved (obviating missing data problem) and reversals are taken into account
- Hypothetical ancestor properly defined by using real ‘outgroups’ (*Diabolepis*, *Psarolepis*)

LUNGFISH EVOLUTION

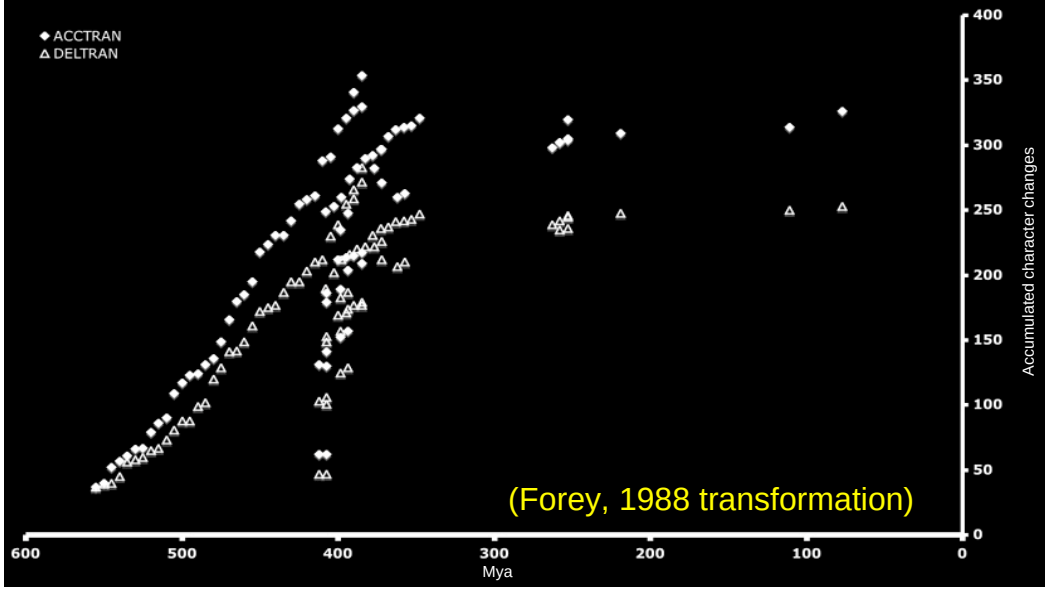
Lloyd *et al.*, in prep.



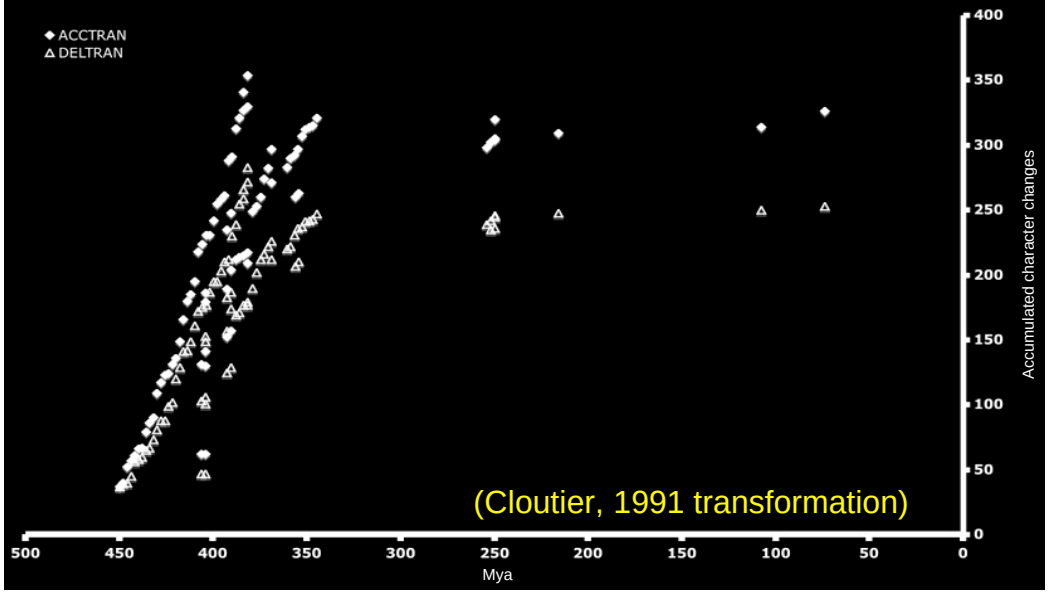
RATE CALCULATION

Rate = Δx / Δt

RATE CALCULATION PROBLEMS



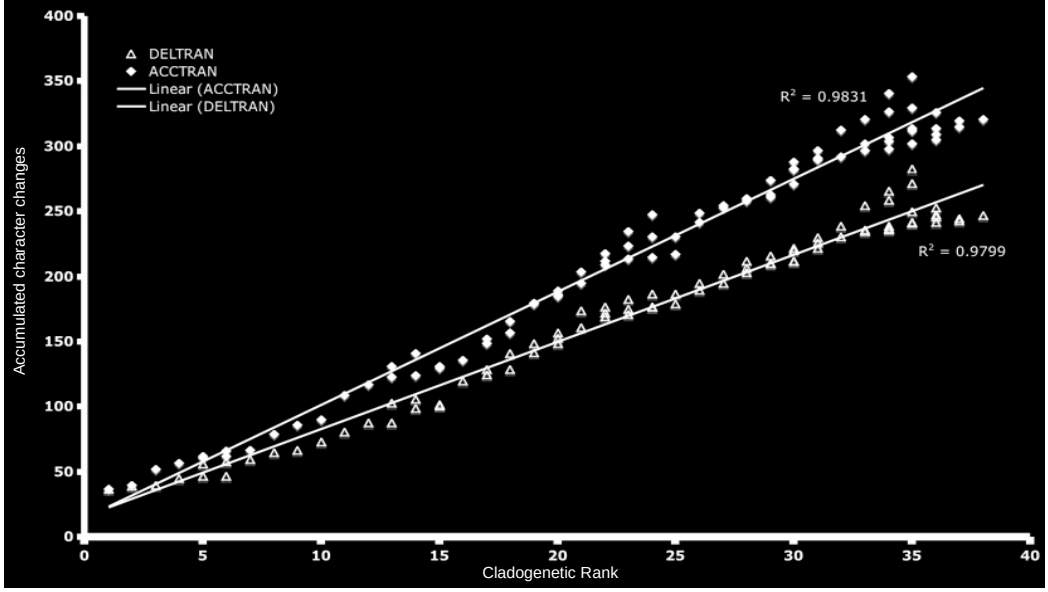
RATE CALCULATION PROBLEMS



RATE CALCULATION

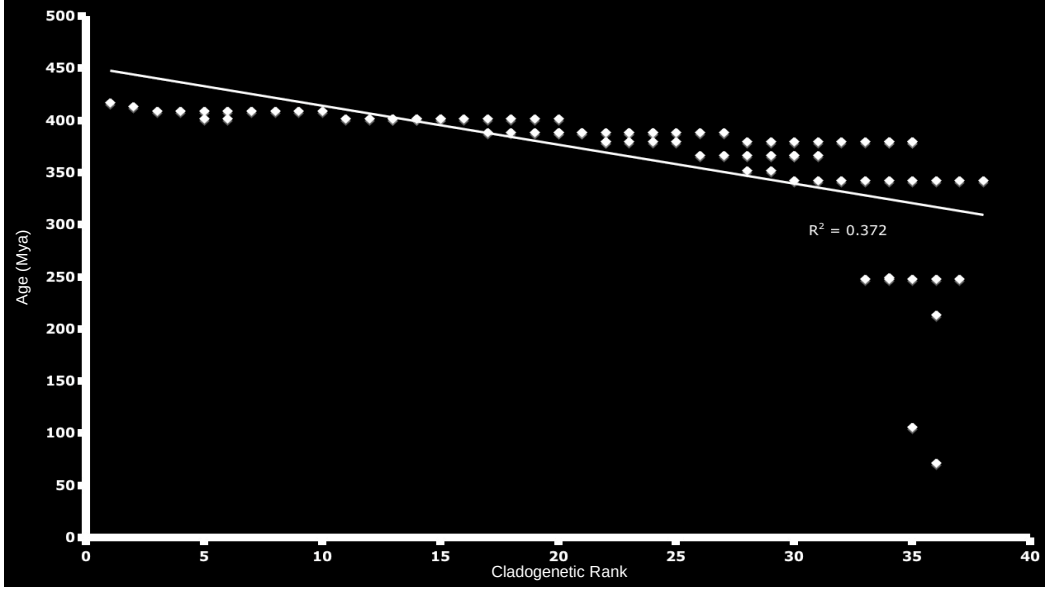
Rate = Δx / Δt

SCORE VS RANK: CORRECTING FOR TIME



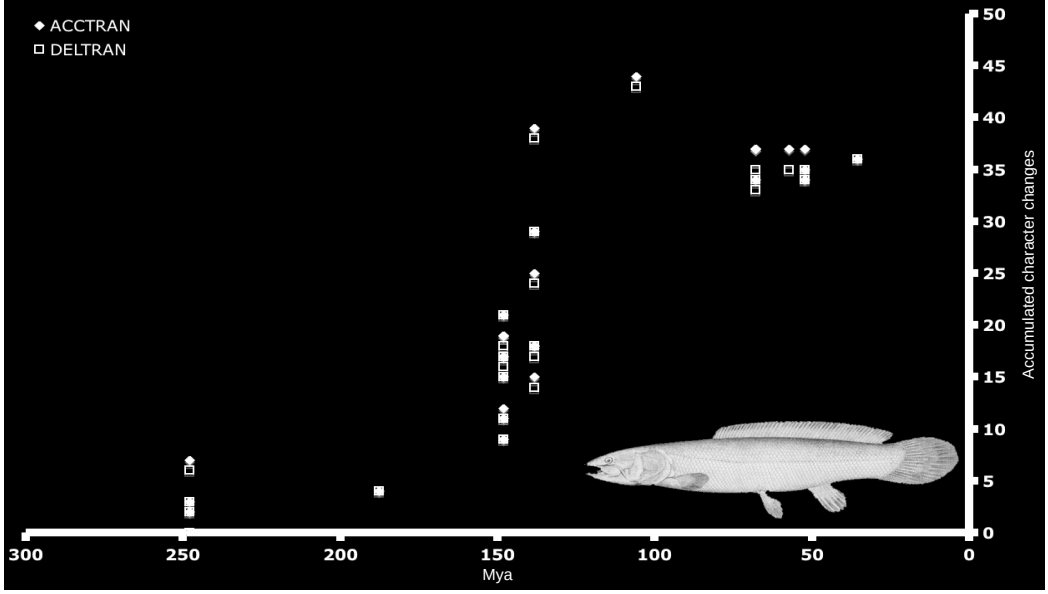
RANK VS TIME:

CORRECTING FOR EVOLUTIONARY CHANGE



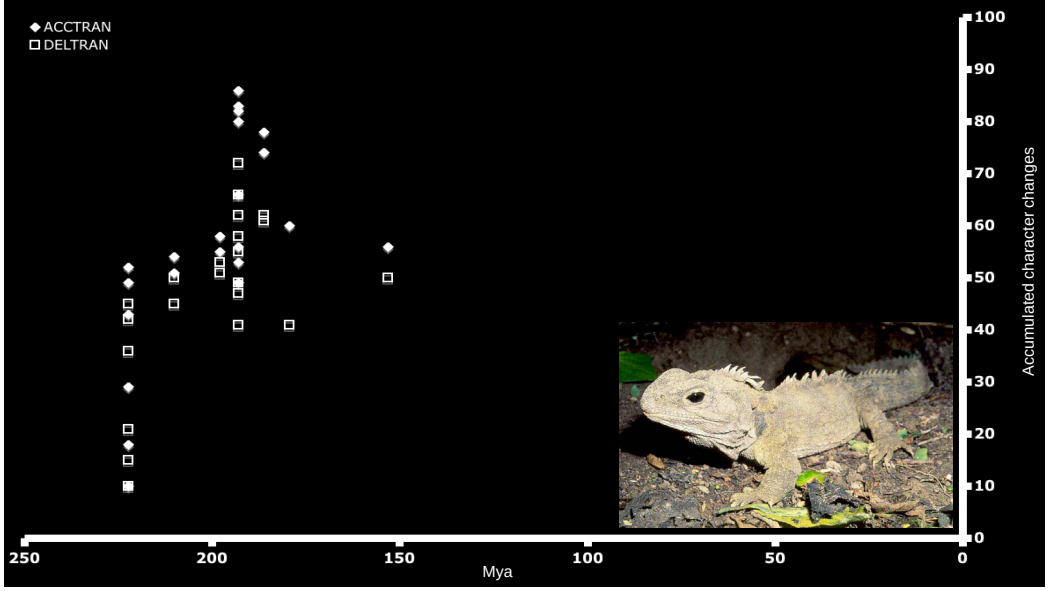
BOWFIN EVOLUTION

Grande and Bemis, 1998



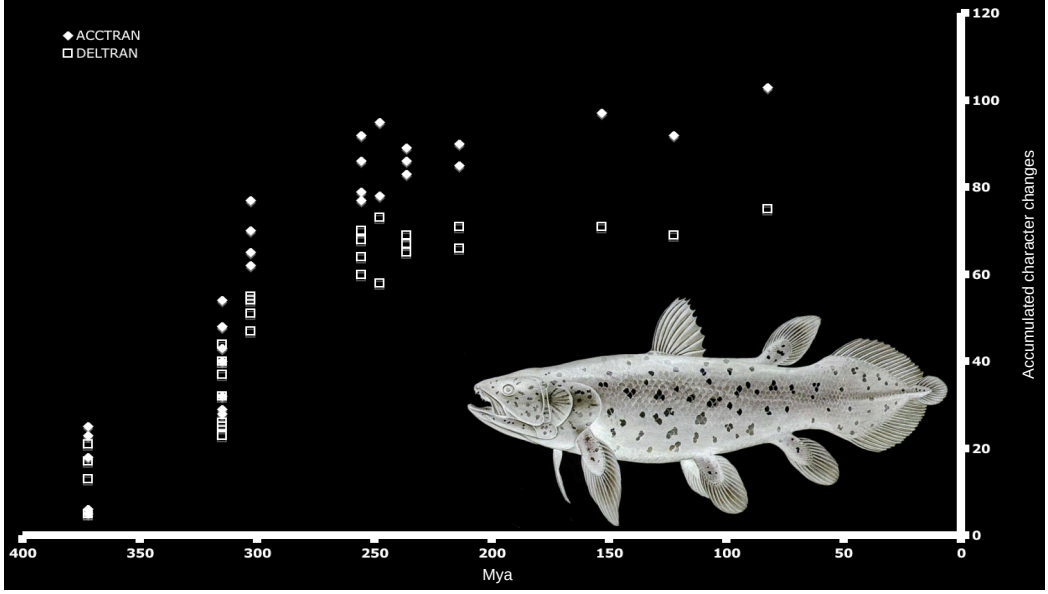
SPHENODONT EVOLUTION

Lloyd *et al.*, in prep.



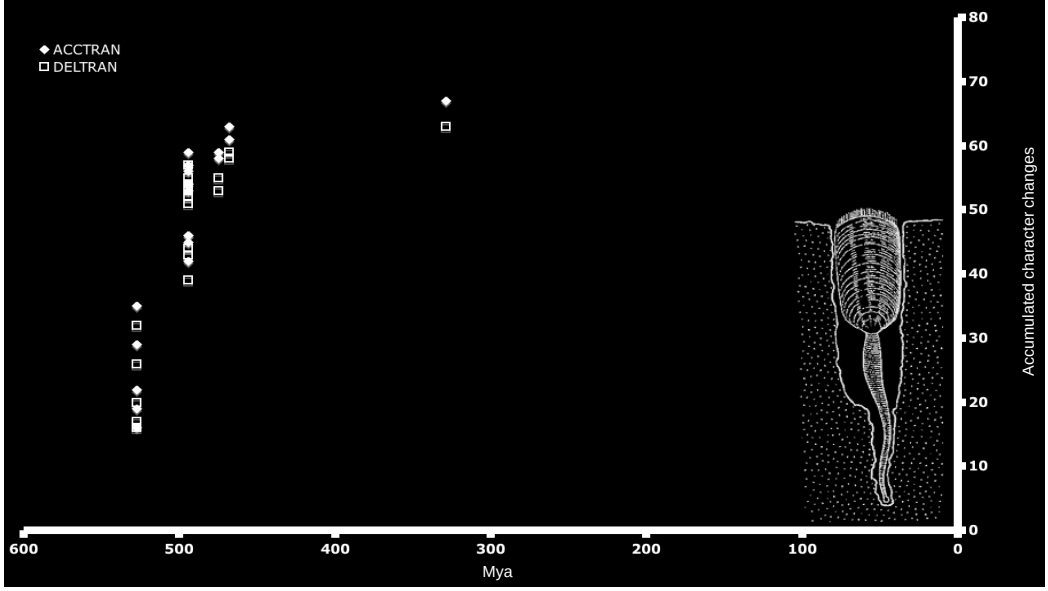
COELOCANTH EVOLUTION

Cloutier, 1991



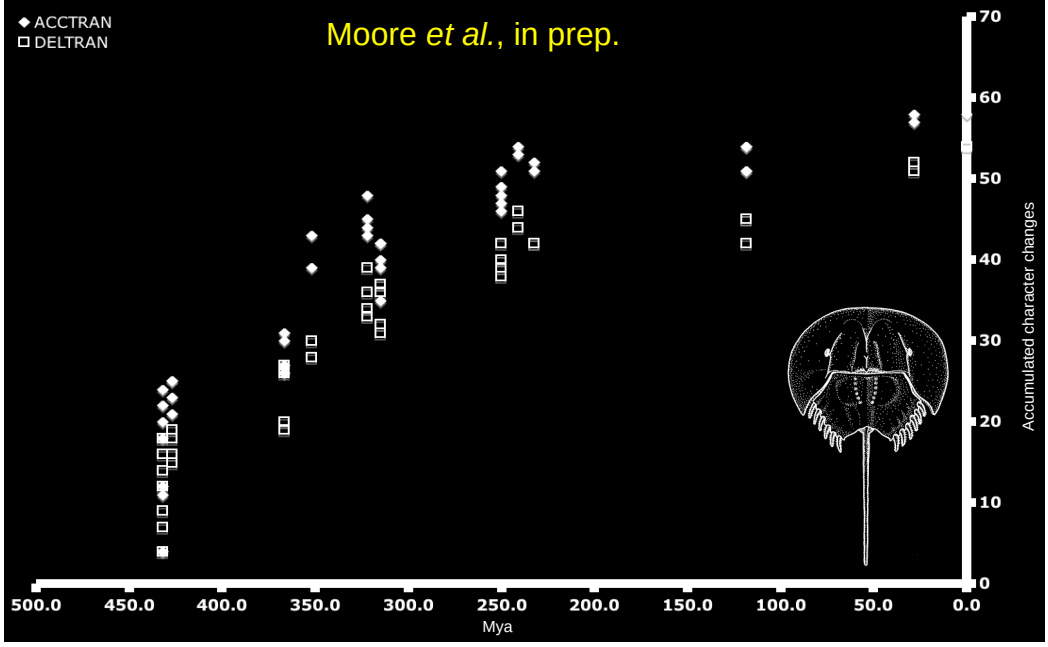
LINGULOID EVOLUTION

Cusack *et al.*, 1999



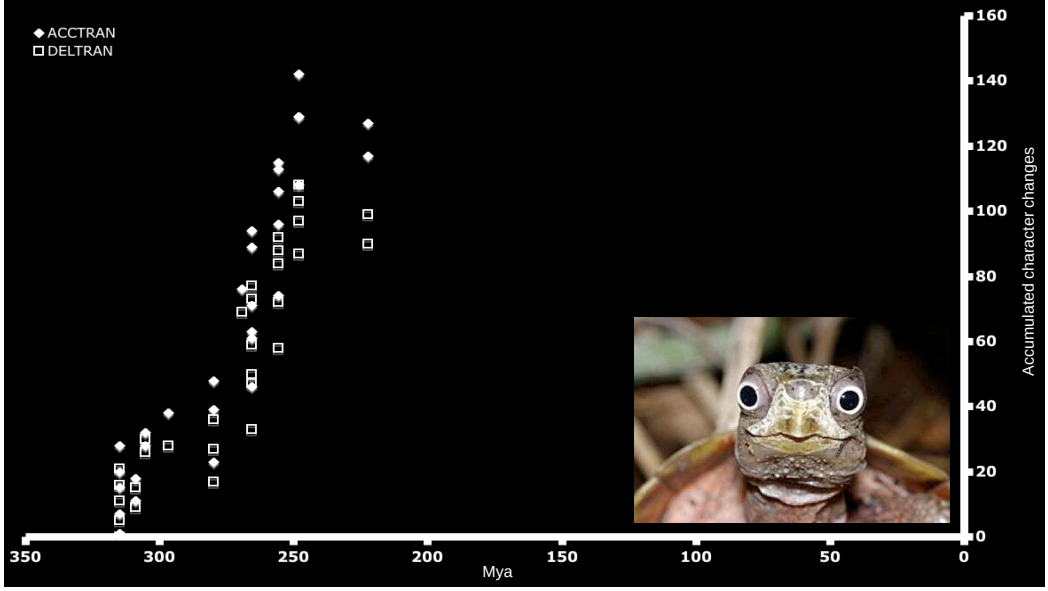
HORSESHOE CRAB EVOLUTION

Moore *et al.*, in prep.



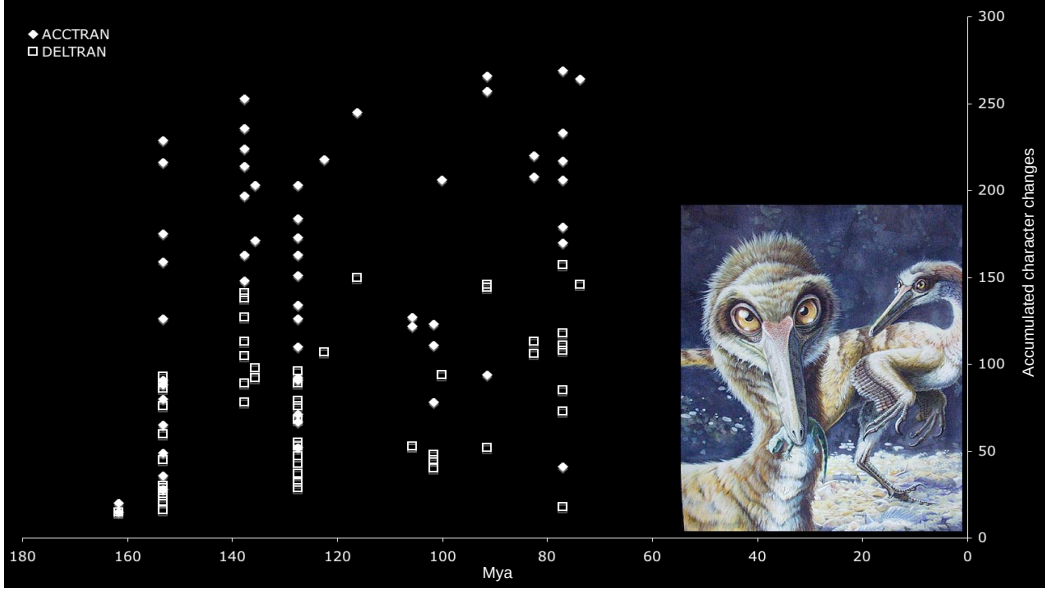
REPTILE EVOLUTION

Rieppel and deBraga, 1996



MANIRAPTORAN EVOLUTION

Mackovicky *et al.*, 2005



THE NEXT TWO YEARS

- Apply modified Westoll method to many more matrices
- Comparisons to make:
  - 'Living fossils' vs. 'normal' taxa
  - Vertebrates vs. Invertebrates vs. Plants
  - Species vs. Genus vs. Family etc.
  - Molecules vs. Morphology
  - Ontogeny vs. Phylogeny

ACKNOWLEDGEMENTS

Sebastian Apesteguia (Museo Argentino de Ciencias Naturales), Matt Friedman (University of Chicago), and Hans-Peter Schultze (University of Kansas) kindly supplied copies of their matrices for analysis. Matt also helped in tracking down the stratigraphic ranges of some of the more obscure lungfish taxa. This presentation was improved thanks to the constructive criticism of the Palaeontology Discussion Group (PDG) who were subjected to an earlier version.