THERE’S SOMETHING ABOUT LEONARD: CHARACTER ACQUISITION, RATES OF EVOLUTION, AND ‘LIVING FOSSILS’

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“…paleontology is the only four dimensional biological science; time, ‘tempo,’ is inherent in it.” (G. G. Simpson, 1984)
TEMPO AND MODE

- 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’)

George Gaylord Simpson
1902 - 1984

PRINCETON CONFERENCE ON GENETICS, PALEONTOLOGY, AND EVOLUTION
JANUARY 1947

T. S. Westoll
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 = \( \Delta x / \Delta t \)
RATE CALCULATION PROBLEMS

(Forey, 1988 transformation)

(Rate Calculation Problems)

(Cloutier, 1991 transformation)
RATE CALCULATION

Rate = \frac{\Delta x}{\Delta t}

SCORE VS RANK: CORRECTING FOR TIME
RANK VS TIME: CORRECTING FOR EVOLUTIONARY CHANGE

R² = 0.372

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

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