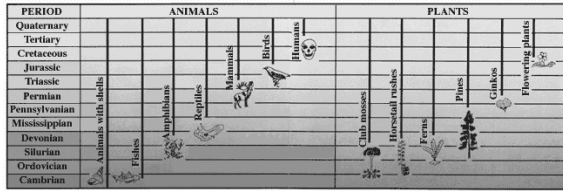
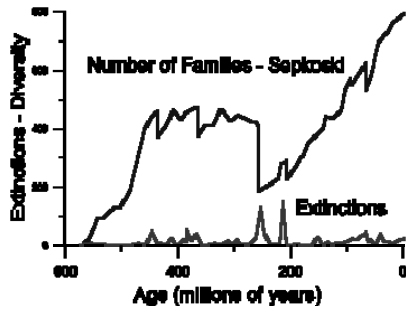


Macroevolution



Stratigraphic ranges and origins of some major groups of animals and plants.

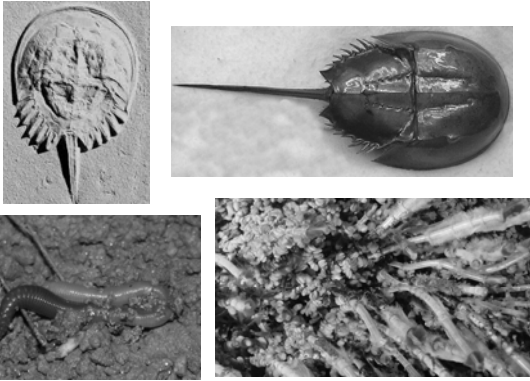
Evolution of Diversity



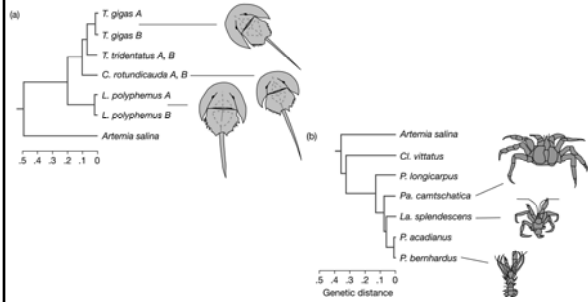
Macroevolution

- Macroevolutionary Rates (Revisited)
- Quantifying Rates of Change
- Inferences about Evolutionary Process
- Trends in Macroevolution

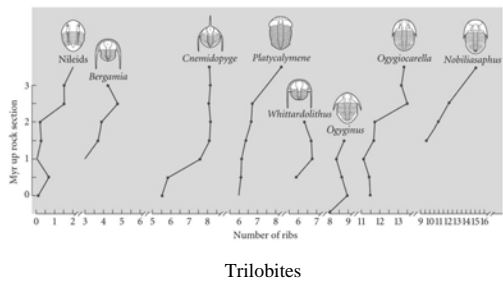
Rates of Evolution Vary Among Characters



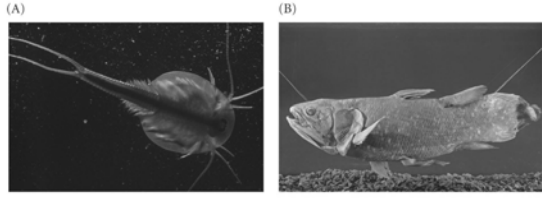
Genetic and Morphological Rates may Differ



Rates Vary Among & Within Lineages



Two “living fossils”



Tadpole Shrimp
since Triassic

Coelacanth
since Devonian

Quantifying Rates, “the darwin”
(Describes character changes)

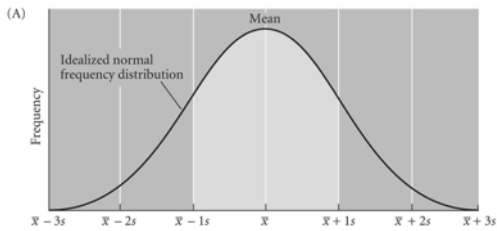
r (in darwins) = $(\ln(x_1) - \ln(x_2))/\Delta t$,
with t measured in millions of years

If $x_2 = 1$, and $x_1 = 2.718$, and t is 10 million yrs,

$r = (\ln(2.718) - \ln(1))/10 = 1/10 = 0.1$ darwins

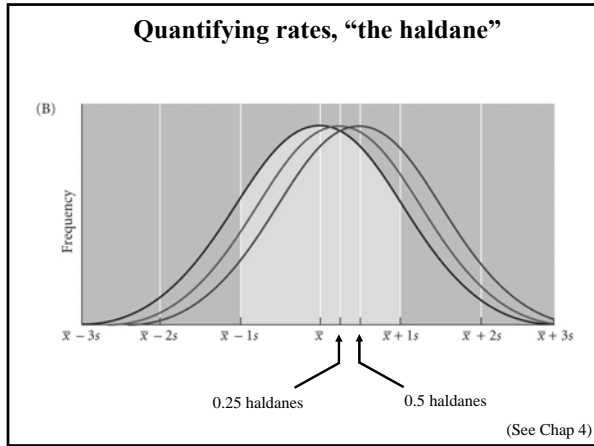
(See Chap 4)

Quantifying rates, “the haldane”



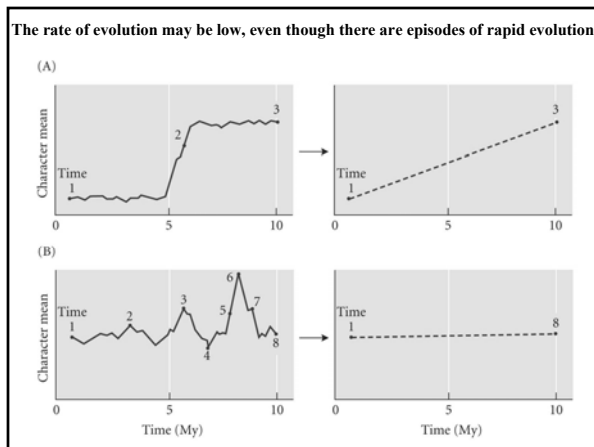
Rate: number of SD by which character mean changes per generation.

(See Chap 4)



Rates Observed Depend on the Time Interval

Scenario	Time Interval	Range of rates, d (mean in parentheses)
Selection expts	1.5-10 yr	12,000-200,000 (58,700)
Colonization	70-300 yr	0-79,700 (370)
Fossil invertebrates	0.3-350 Myr	0-3.7 (0.07)
Fossil vertebrates	8000 yr - 98 Myr	0-26.2 (0.08)

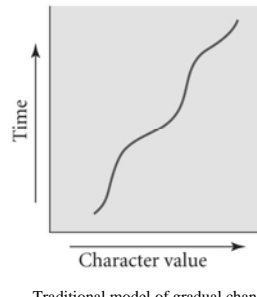


Macroevolutionary Inferences, Based on Rates

(A) Hypothetical data



(B) Phyletic gradualism

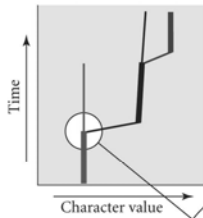


Traditional model of gradual change without any divergence.

(See Chap 4)

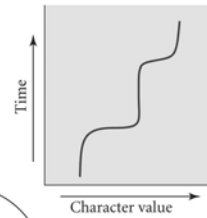
Macroevolutionary Inferences, Based on Rates

(C) Punctuated equilibrium

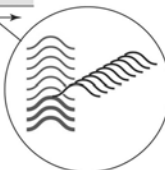


Divergence occurs rapidly then back to stasis.

(D) Punctuated gradualism

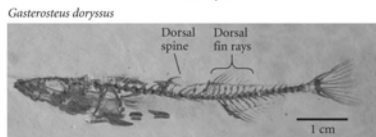
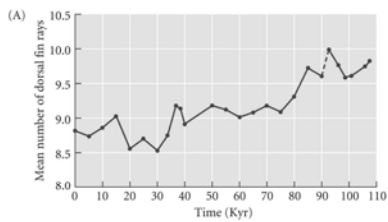


A lineage passes through rapid spurts of change from one equilibrium to another.

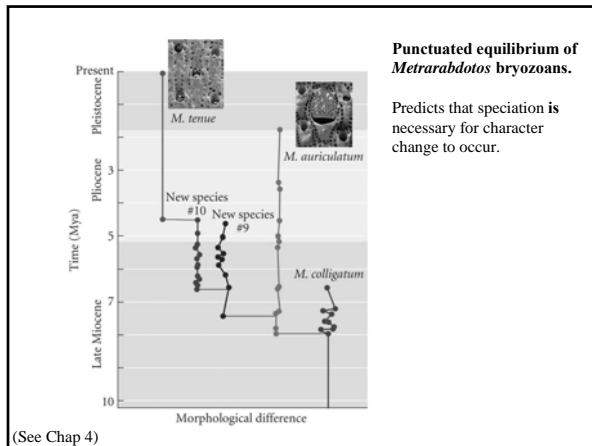


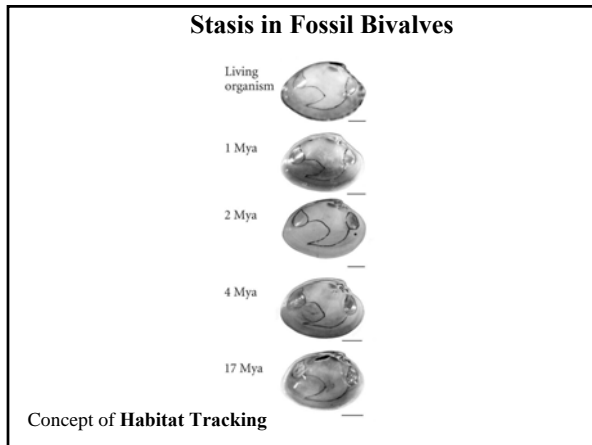
(See Chap 4)

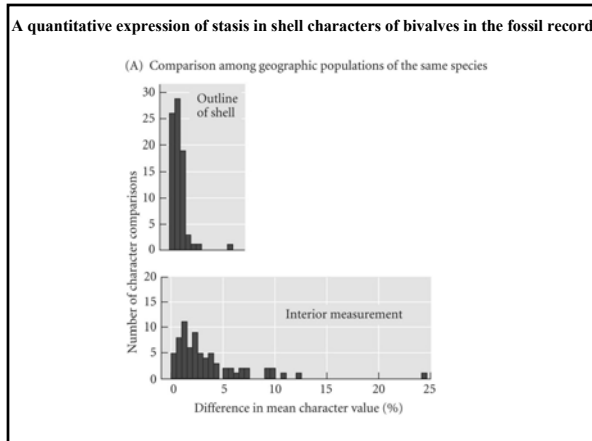
Gradual Evolution in Stickleback Fish



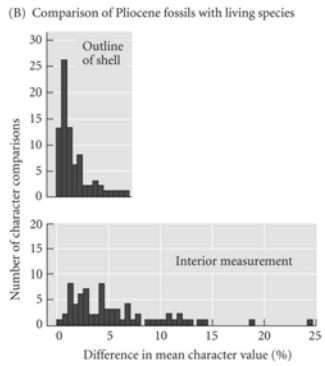
(See Chap 4)

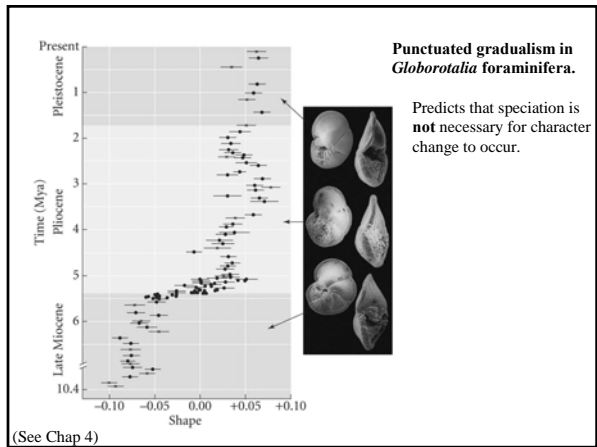


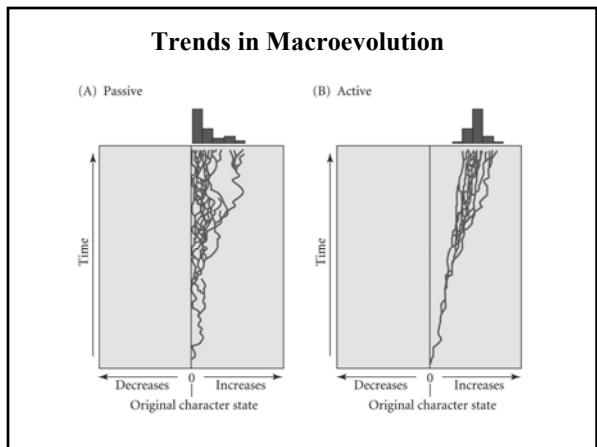




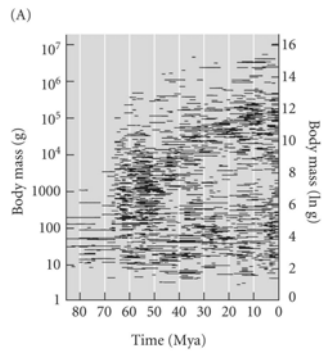
A quantitative expression of stasis in shell characters of bivalves in the fossil record



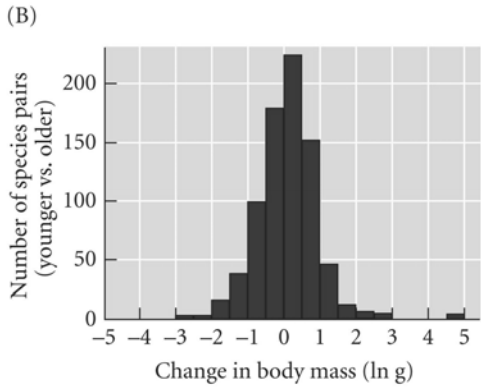




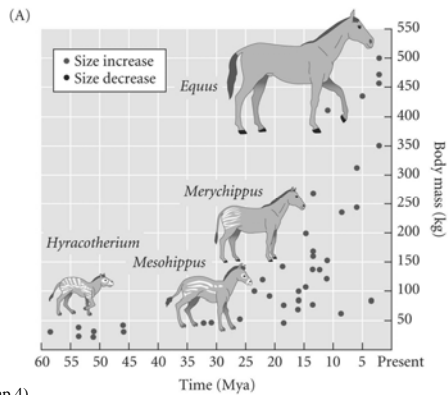
Cope's Rule in Mammals: A Passive Trend



Cope's Rule in Mammals: A Passive Trend

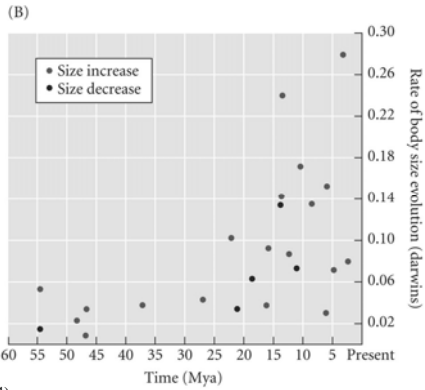


Evolution of body mass in the horse family, *Equidae*



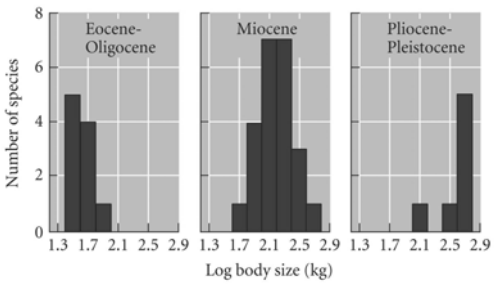
(See Chap 4)

Evolution of body mass in the horse family, *Equidae*



(See Chap 4)

Cope's Rule in Horses: An Active (driven) Trend



Change in max, mean and min sizes!

Evolution of Complexity: A Passive Trend

