Stephen Jay Gould

Brian O'Meara
EEB464 Fall 2018

Learning objectives:

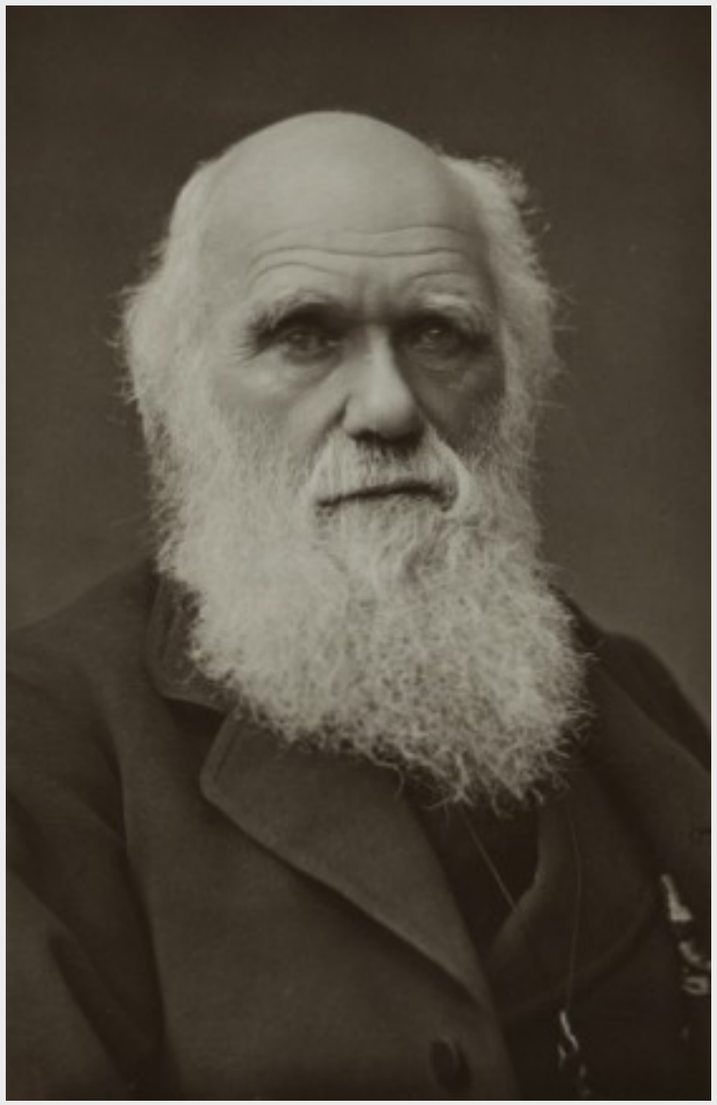
Who was Gould?

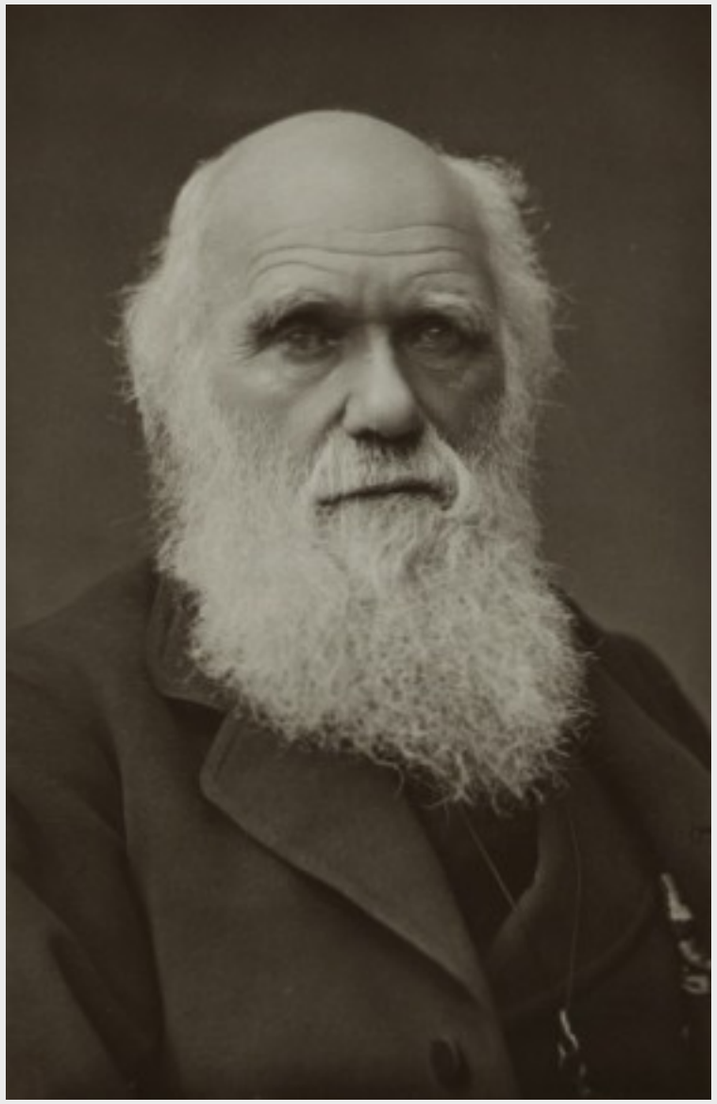
Punctuated equilbrium

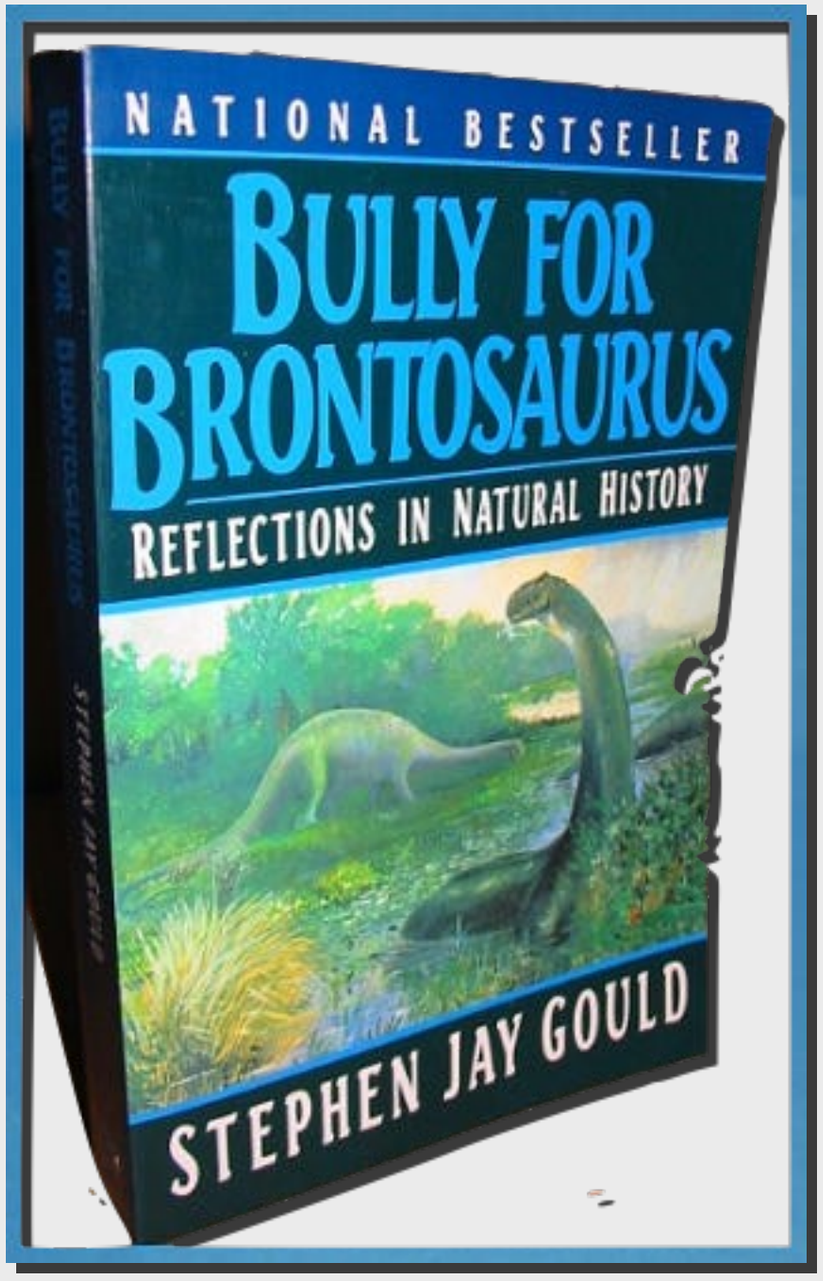
Adaptationism

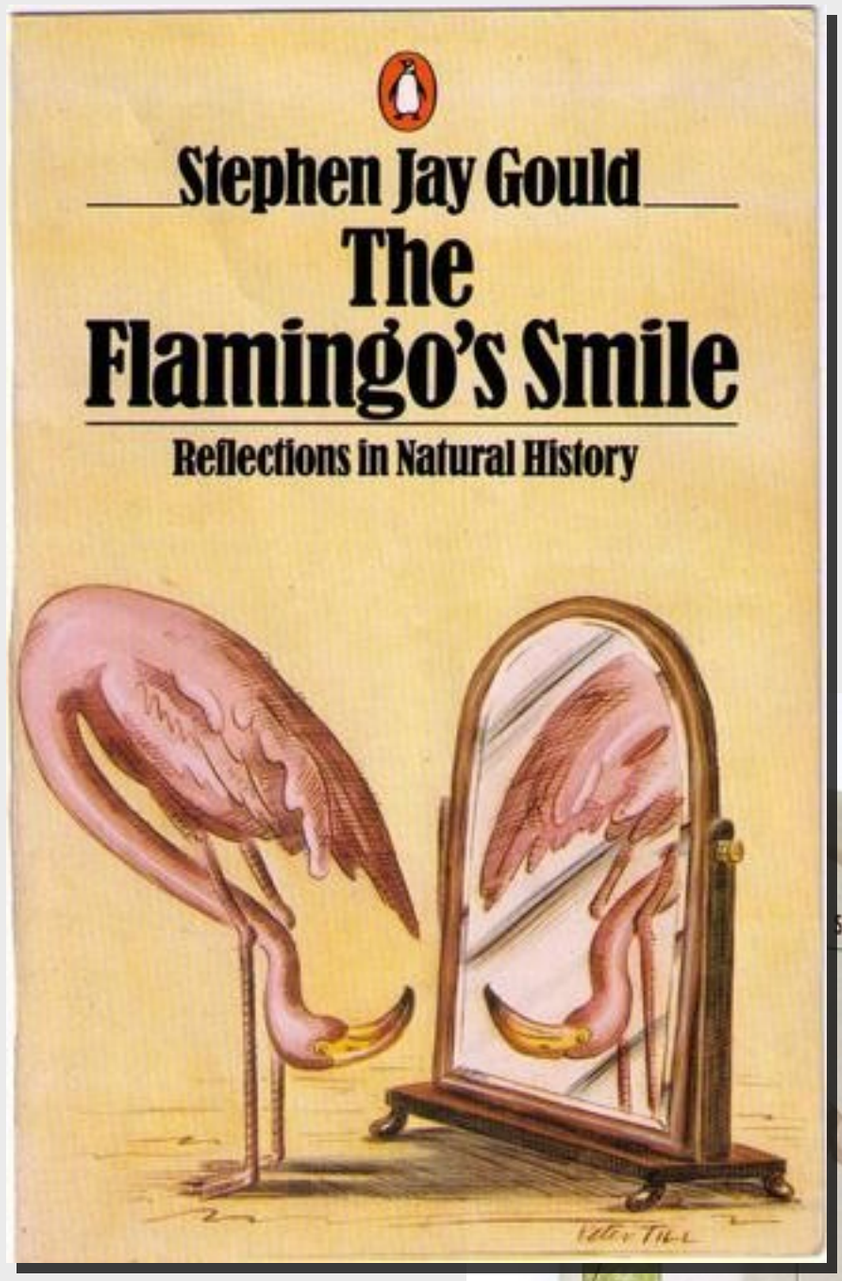
How we argue in macroevolution

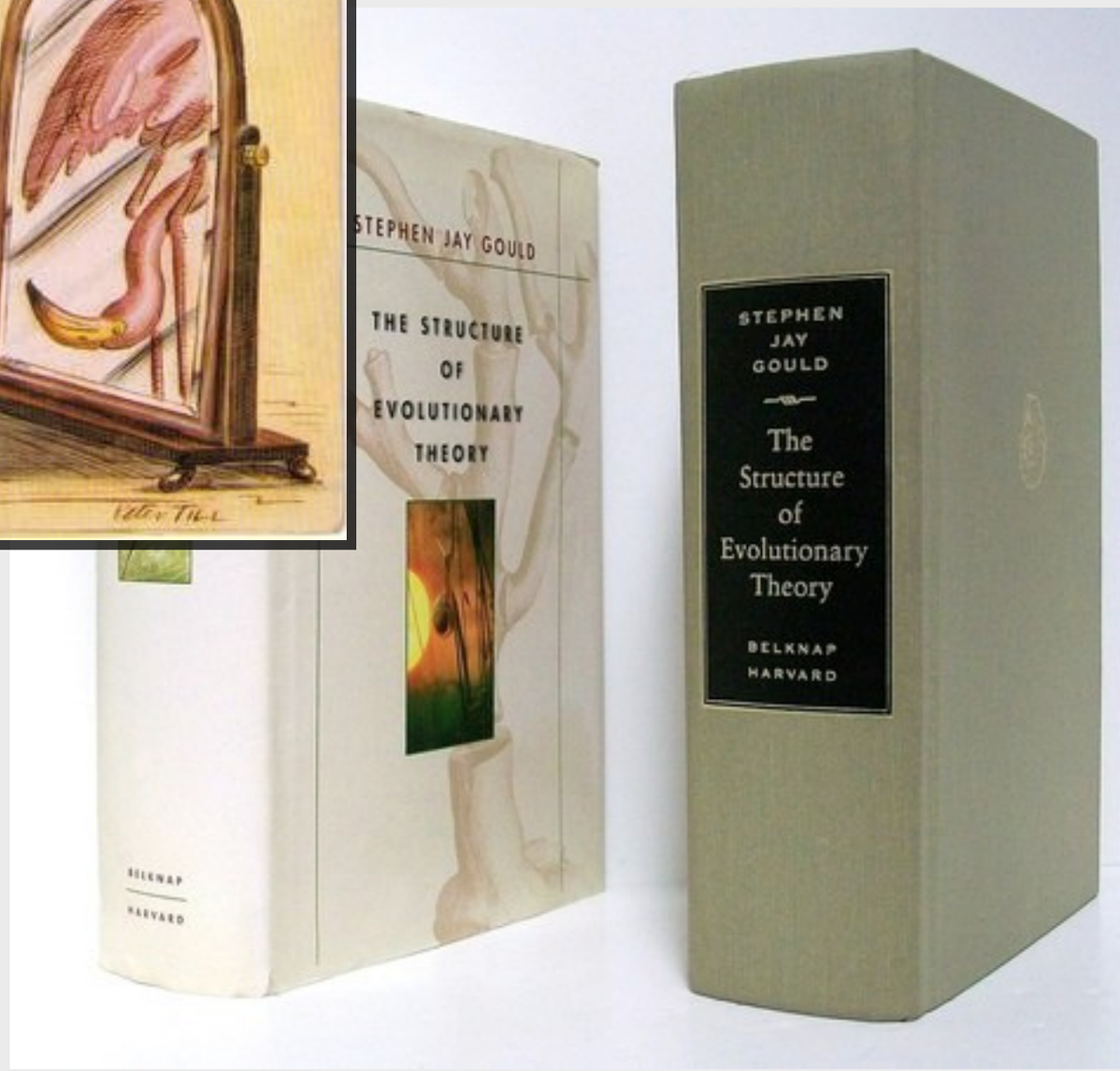
Pair or single presentation. Imagine you are trying to get money to study a macroevolutionary question. You have to make a compelling case to a potential funder (i.e., the NSF will give you $15K to study it, or a professor might offer you a place in her lab to work on this). You should include 1) why that question is interesting (this should include what is known about it), 2) how you plan to address it, 3) what potential outcomes of your work may be, and 4) the implications of these. 10 minute talk (PowerPoint, Keynote, PDF, etc.). Be sure to include references in your slides.






NATIONAL BESTSELLER
BULLY FOR BRONTOSAURUS
REFLECTIONS IN NATURAL HISTORY
STEPHEN JAY GOULD

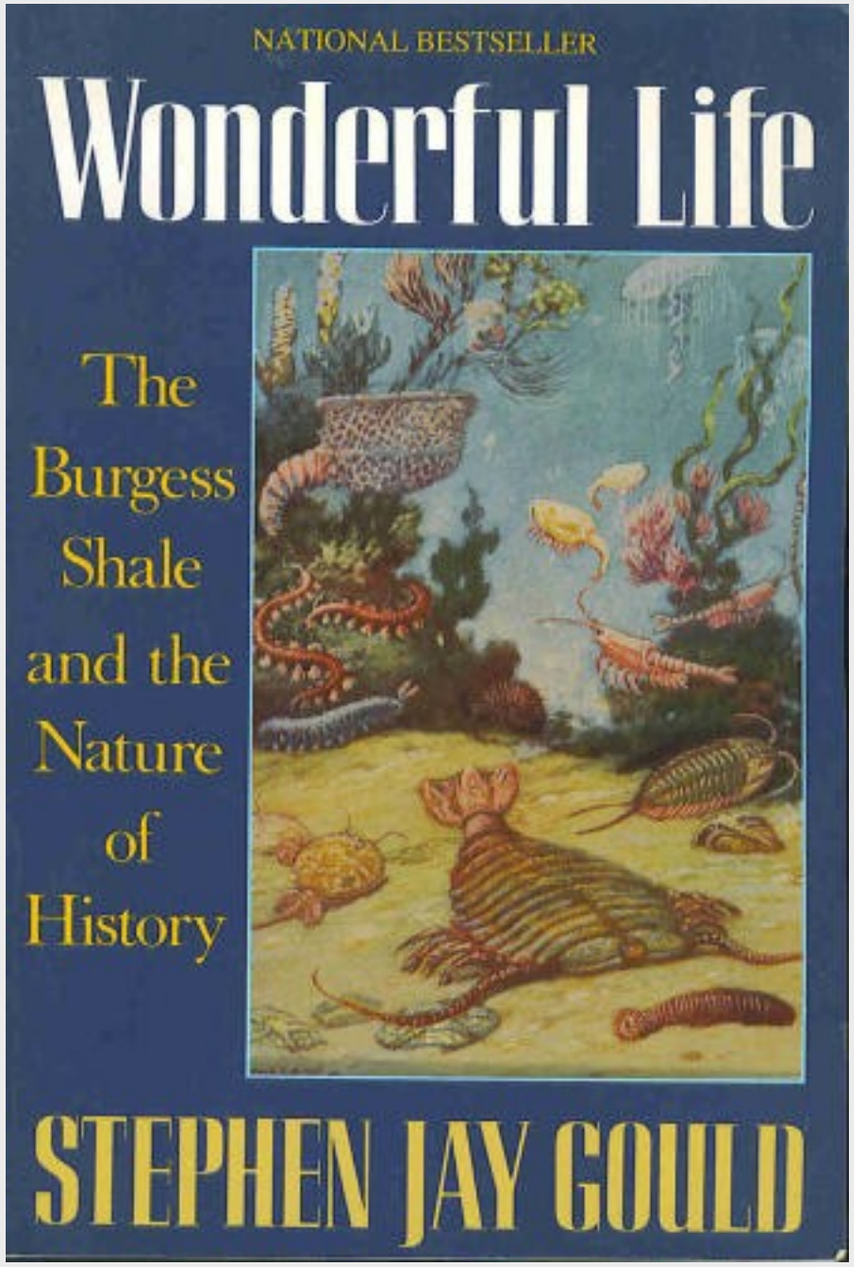

Stephen Jay Gould
The Flamingo's Smile
Reflections in Natural History


STEPHEN JAY GOULD
THE STRUCTURE OF EVOLUTIONARY THEORY
BELKNAP
HARVARD
STEPHEN JAY GOULD
The Structure of Evolutionary Theory
BELKNAP HARVARD

Popularization

Punctuated equilibrium

Arguments against panselectionism


NATIONAL BESTSELLER
Wonderful Life
The Burgess Shale and the Nature of History
STEPHEN JAY GOULD

“We talk about the ‘march from monad to man’ (old-style language again) as though evolution followed continuous pathways of progress along unbroken lineages. Nothing could be further from reality. I do not deny that, through time, the most ‘advanced’ organism has tended to increase in complexity. But the sequence from protozoan to jellyfish to trilobite to nautiloid to armored fish to dinosaur to monkey to human is no lineage at all, but a chronological set of termini on unrelated darwiniana trunks. Moreover life shows no trend to complexity in the usual sense—only an asymmetrical expansion of diversity around a starting point constrained to be simple.”

— "Tires to Sandals," Eight Little Piggies, New York: W. W. Norton, 1993, p. 322.

“Well evolution is a theory. It is also a fact. And facts and theories are different things, not rungs in a hierarchy of increasing certainty. Facts are the world's data. Theories are structures of ideas that explain and interpret facts. Facts do not go away when scientists debate rival theories to explain them. Einstein's theory of gravitation replaced Newton's, but apples did not suspend themselves in mid-air, pending the outcome. And humans evolved from apelike ancestors whether they did so by Darwin's proposed mechanism or by some other yet to be discovered.”

— "Evolution as Fact and Theory," Hen's Teeth and Horse's Toes, New York: W. W. Norton, 1994, p. 254.

Punctuated equilibrium

1. Expectations of theory color perception

2. Paleontology's view of speciation has been dominated by ... "phyletic gradualism." It holds that new species arise from the slow and stead transformation of entire populations.

3. The theory of allopatric ... speciation suggests a very different interpretation of paleontological data. If new species arise very rapidly in small, peripherally isolated local populations, then the great expectation of insensibly graded fossil sequences is a chimera.... Many breaks in the fossil record are real.

4. The history of life is more accurately represented by a picture of "puntuated equilibria" than by the notion of phyletic gradualism. The history of evolution is not one of stately unfolding, but a story of homeostatic equilibria, disturbed only "rarely" (i.e., rather often in the fullness of time) by rapid and episodic events of speciation.

Eldredge and Gould 1971

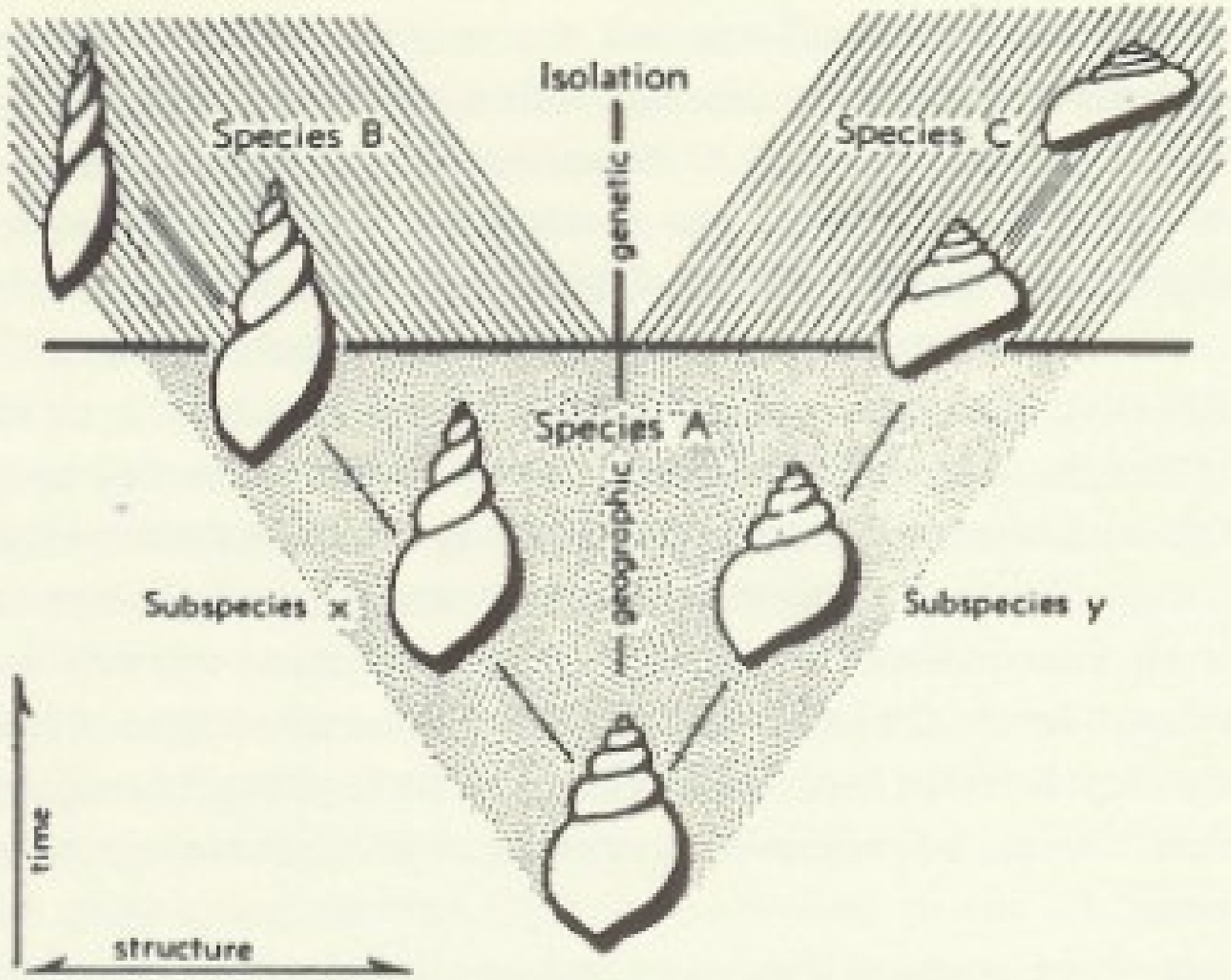


Figure 5–3: A hypothetical case of geographic speciation viewed from the perspective of phyletic gradualism—slow and gradual transformation in two lineages. From Moore, Lalicker, and Fischer, 1952; figure 1–15.

Eldredge and Gould 1971

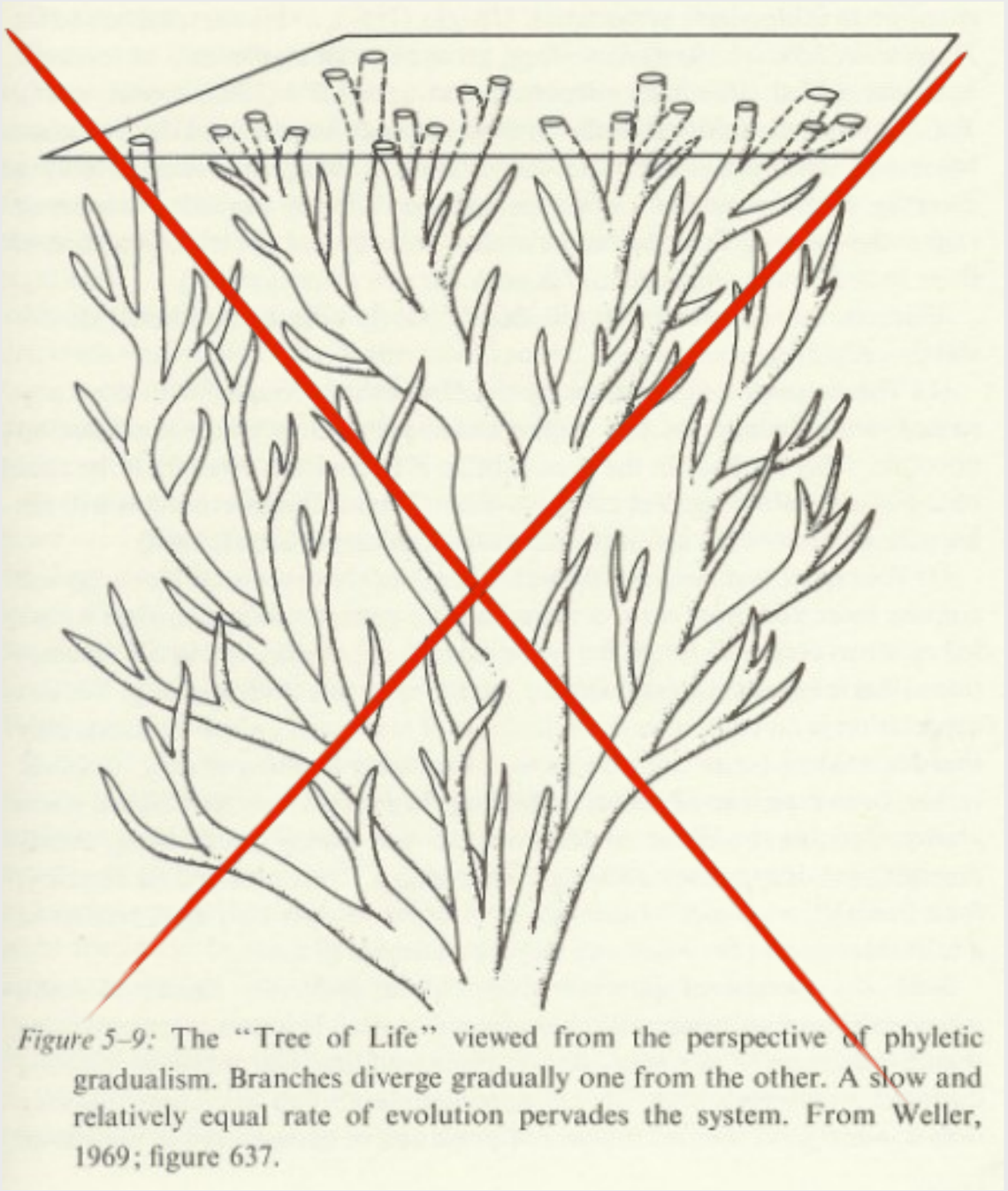
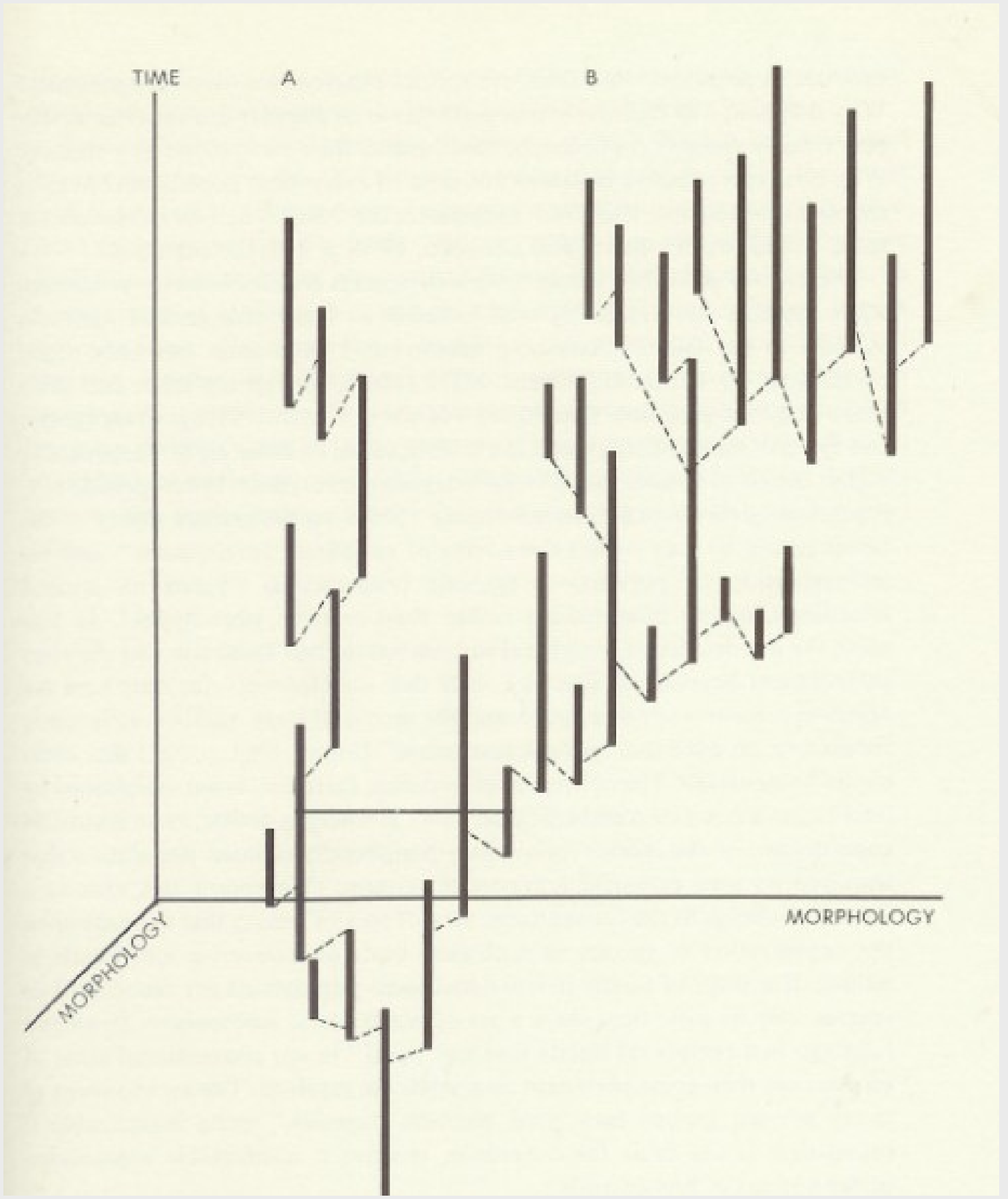


Figure 5–9: The "Tree of Life" viewed from the perspective of phyletic gradualism. Branches diverge gradually one from the other. A slow and relatively equal rate of evolution pervades the system. From Weller, 1969; figure 637.



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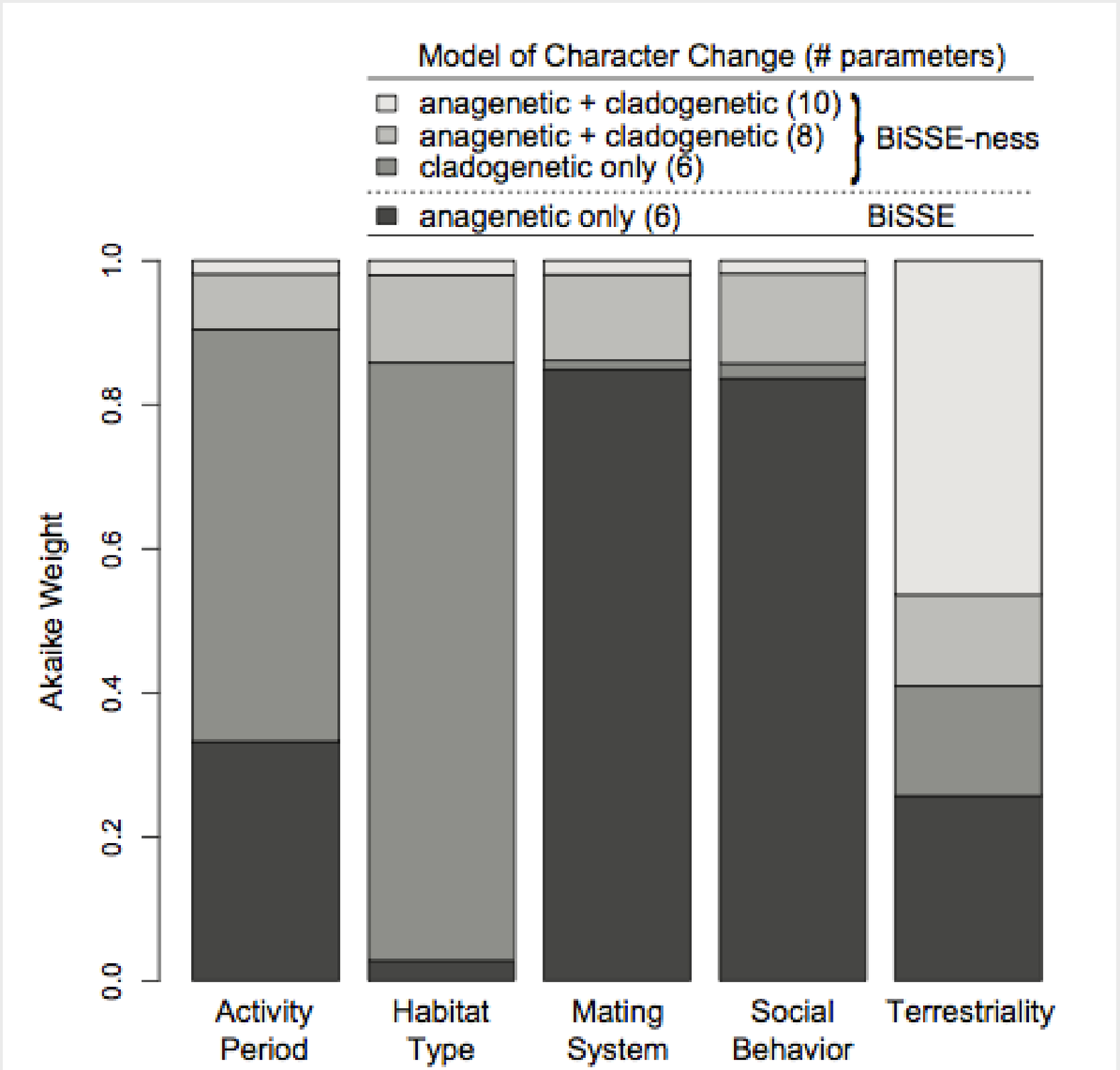
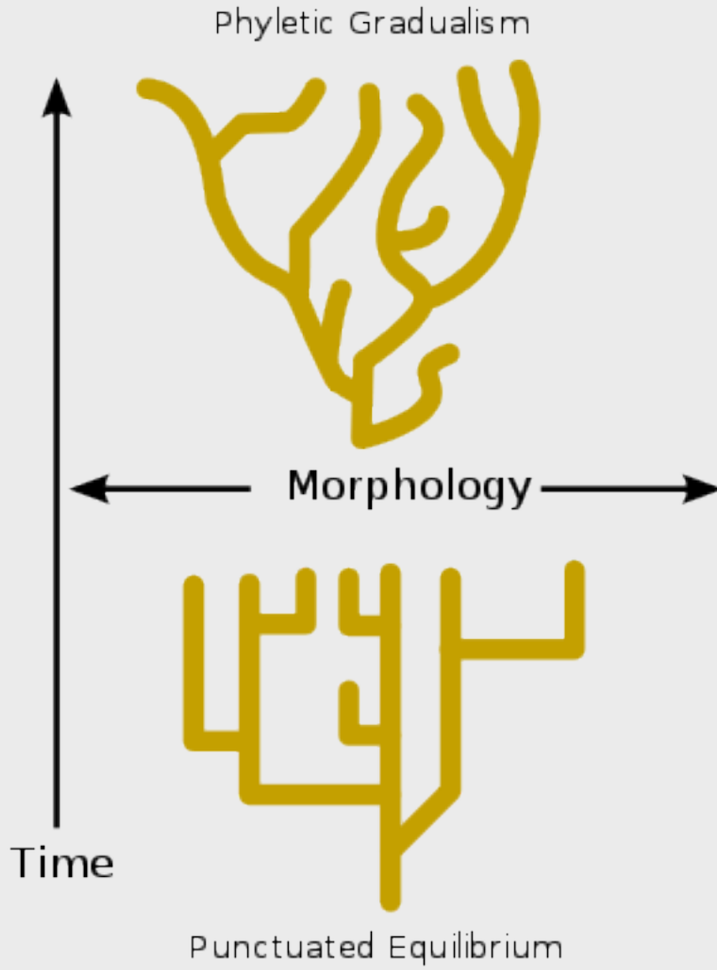




Magnuson-Ford and Otto, 2012

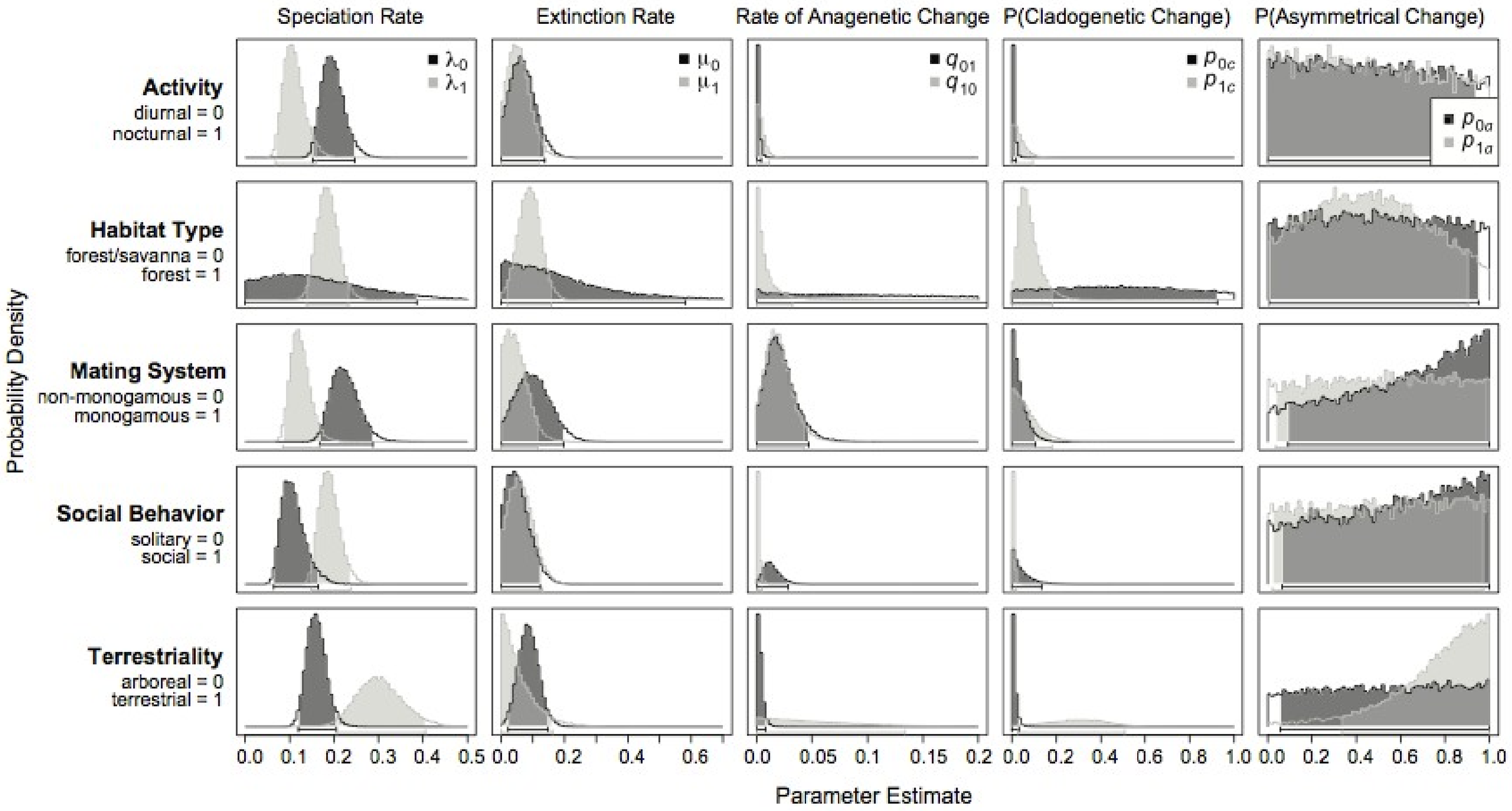


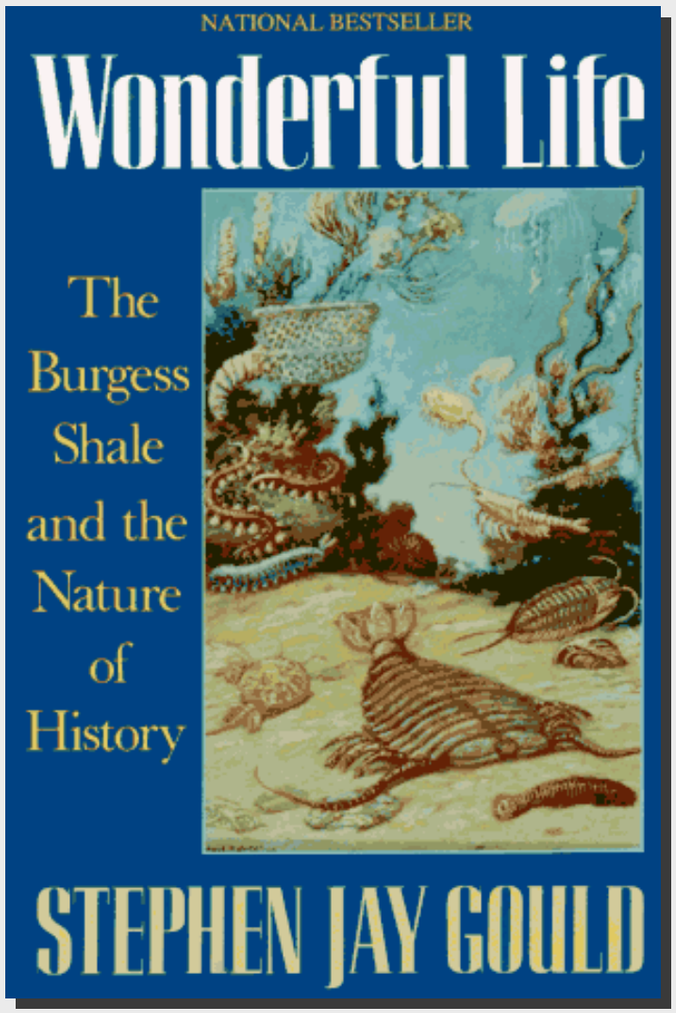
Figure 6: Posterior distributions of the parameter estimates using the full 10-parameter "Binary-State Speciation and Extinction–node enhanced state shift" (BiSSE-ness) model for the five traits and across the 20 trees included in the primate diversification analysis. The bars beneath each plot correspond to the shaded areas, indicating the 95% highest posterior density interval (see table S1, available online in a PDF).

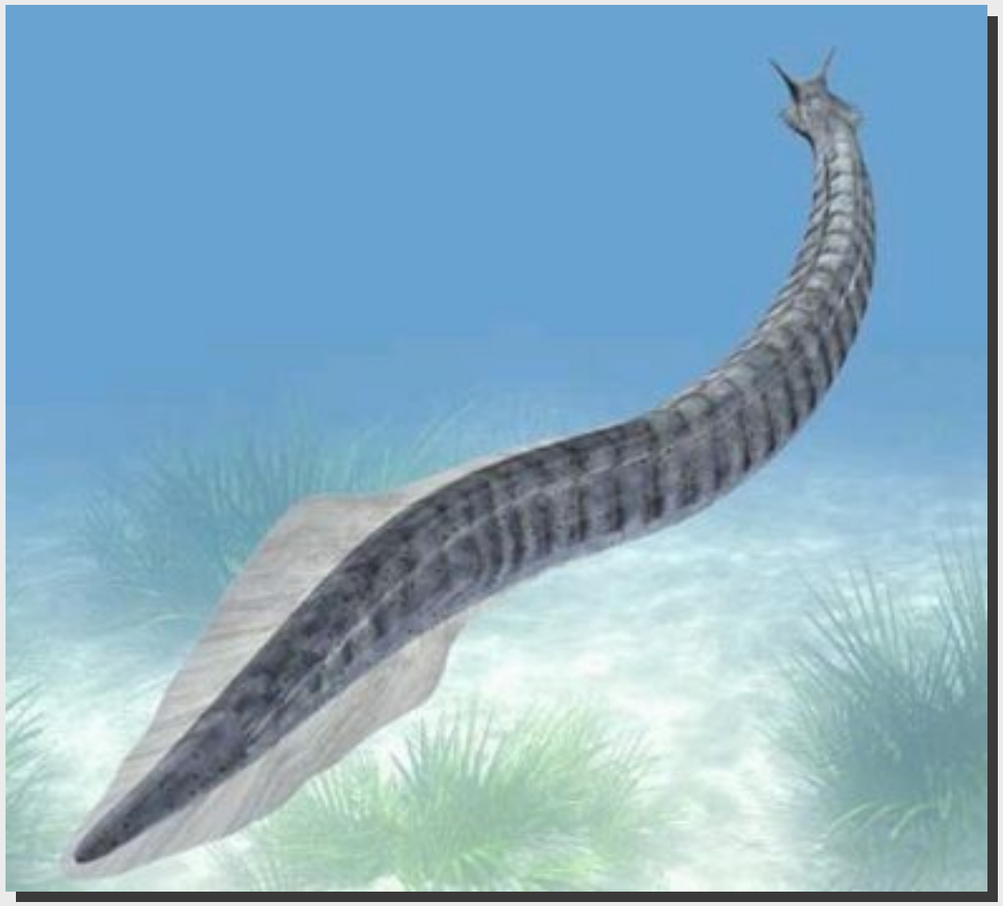
Magnuson-Ford and Otto, 2012

An adaptationist programme has dominated evolutionary thought in England and the United States during the past 40 years. It is based on faith in the power of natural selection as an optimizing agent. It proceeds by breaking an organism into unitary 'traits' and proposing an adaptive story for each considered separately. Trade-offs among competing selective demands exert the only brake upon perfection; non-optimality is thereby rendered as a result of adaptation as well. We criticize this approach and attempt to reassert a competing notion (long popular in continental Europe) that organisms must be analysed as integrated wholes, with Bauplane so constrained by phyletic heritage, pathways of development and general architecture that the constraints themselves become more interesting and more important in delimiting pathways of change than the selective force that may mediate change when it occurs. We fault the adaptationist programme for its failure to distinguish current utility from reasons for origin (male tyrannosaurs may have used their diminutive front legs to titillate female partners, but this will not explain why they got so small); for its unwillingness to consider alternatives to adaptive stories; for its reliance upon plausibility alone as a criterion for accepting speculative tales; and for its failure to consider adequately such competing themes as random fixation of alleles, production of non-adaptive structures by developmental correlation with selected features (allometry, pleiotropy, material compensation, mechanically forced correlation), the separability of adaptation and selection, multiple adaptive peaks, and current utility as an epiphenomenon of non-adaptive structures. We support Darwin's own pluralistic approach to identifying the agents of evolutionary change.

Gould & Lewontin, 1979

"Wind the tape of life back to Burgess times, and let it play again. If Pikaia does not survive in the replay, we are wiped out of future history —all of us, from shark to robin to orangutan."
Stephen Jay Gould in Wonderful Life





[W]e come to the most egregious misinterpretation of the Burgess Shale in Gould's book..... Gould sees contingency evolutionary history based on the luck of the draw—as the major lesson of the Burgess Shale. If you rerun the tape of evolution, he says, the results would surely come out differently.... Such a view, with its emphasis on chance and accident, obscures the reality of evolutionary convergence. Given certain environmental forces, life will shape itself to adapt. History is constrained, and not all things are possible.

... If such a quality as intelligence can arise both in human beings and in the octopus—an eight-armed sea animal without a bone in its body—then perhaps there is a course and a direction to evolution that would be achieved despite diverse anatomical starting points.

Contingency or no, I believe that a creature with intelligence and self-awareness on a level with our own would surely have evolved—although perhaps not from a tailless, upright ape. Almost any planet with life, in my view, will produce living creatures we would recognize as parallel in form and function to our own biota....
Simon Conway Morris

Simon Conway Morris and Stephen Jay Gould, "Showdown on the Burgess Shale," Natural History magazine, 107 (10): 48-55.

Conway Morris rests his claim for substantial predictability upon the important evolutionary phenomenon of convergence, or the independent origins of similar and highly adaptive designs in separate lineages.... But I think that Conway Morris has given too prominent a role to an admittedly interesting principle for three reasons:

a) As a striking phenomenon, convergence draws our attention, but I think that we often overestimate its sway.... When I first visited Australia, I expected to be overwhelmed by these demonstrations of convergence, but I encountered just the opposite phenomenon: uniqueness and difference, with convergence as an oddity singled out for textbook illustration. The mammalian fauna of Australia, after all, is dominated by upright and effectively "three-legged" herbivores known as kangaroos—a group with no evolved counterpart elsewhere.

b) Most outstanding examples of convergence build upon an inherited anatomical substrate that evolved by ordinary routes of highly contingent and unrepeatable historical circumstance. For example, the wings of bats, birds, and pterosaurs are convergent but all these structures evolved from vertebrate forelimbs of similar inherited design, not from scratch.....

c) Evidence for convergence requires multiple cases of independent evolution, while the example that we all carry closest to our hearts....—the evolution of consciousness in Homo sapiens—remains an outstanding singleton in the only history of life we know: the story of our own planet .... Consciousness at our level of language and conceptual abstraction has evolved but once on earth—in a small lineage of primates (some 200 species), within a small lineage of mammals (some 4,000 species, while the more successful beetles now number more than half a million), within a phylum that prevailed by contingent good fortune from the Burgess draw. If complex consciousness has evolved but once in the admittedly limited domain of known evidence, how can anyone defend the inevitability of its convergent evolution? -SJ Gould

Simon Conway Morris and Stephen Jay Gould, "Showdown on the Burgess Shale," Natural History magazine, 107 (10): 48-55.

Full

Diversification Only

Transition Only