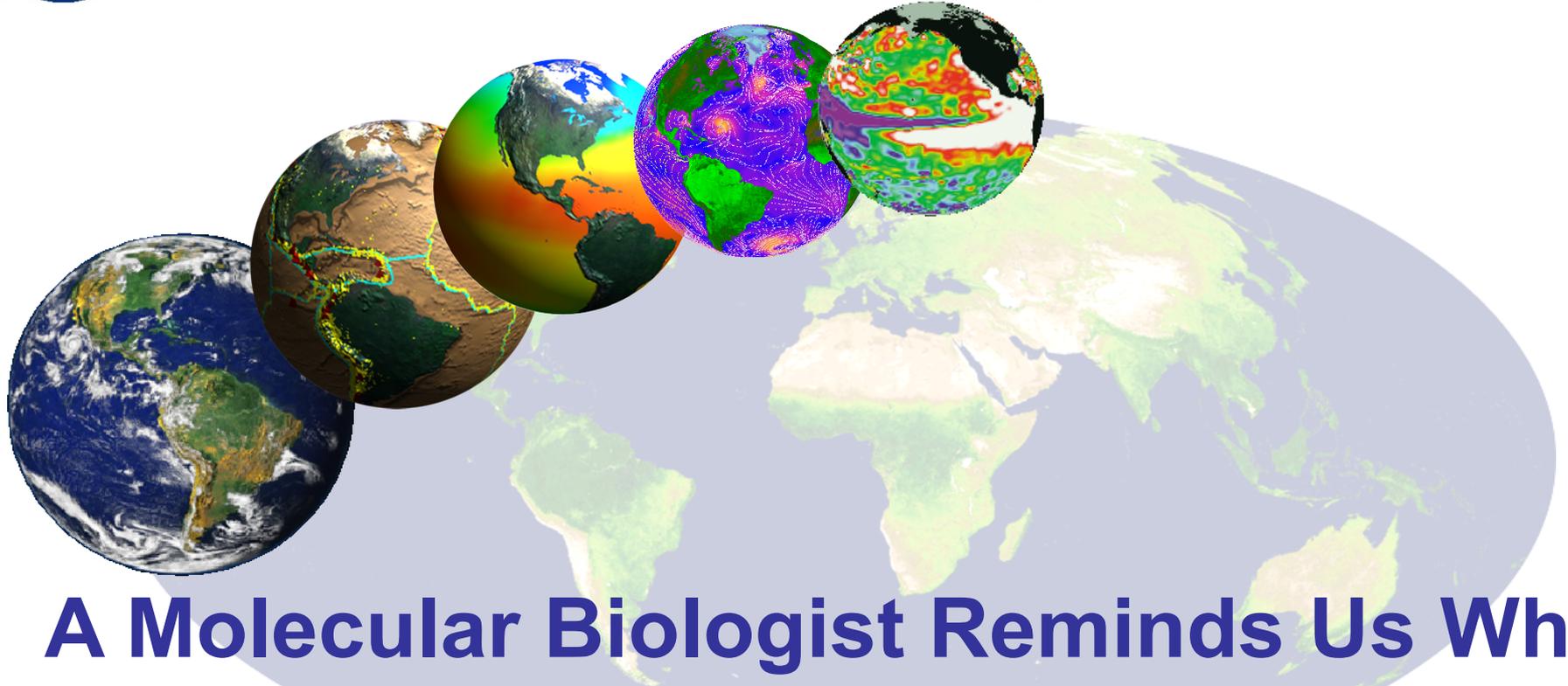




2017 Biodiversity and Ecological Forecasting Team Meeting
Holiday Inn Capitol, Washington, DC



A Molecular Biologist Reminds Us Why We're Here or Look at All We've Got

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All the World's a Stage

As You Like It Act II, Scene VII

All the world's a stage, And all the men and women merely players; They have their exits and their entrances, And one man in his time plays many parts, His acts being seven ages.

A Biologist's View -

The Play: Evolution by Natural Selection

The Stage: The Earth System (Abiotic Environment)

The Players: Life on Earth (of which its diversity is a fundamental trait)

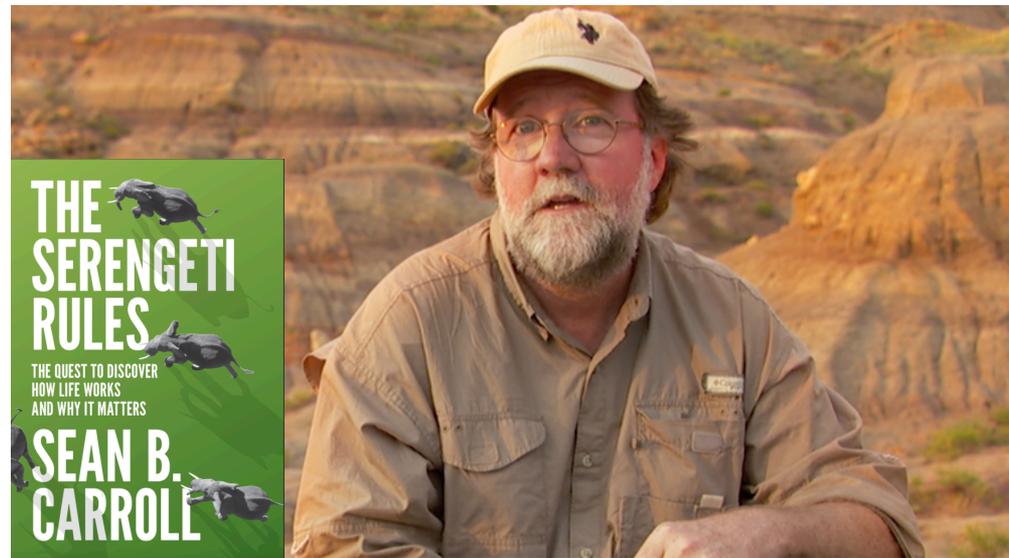


William Shakespeare (Source: <https://www.poets.org/poetsorg/poet/william-shakespeare>)

The Serengeti Rules

An evo-devo molecular ecologist proposes uniting biologists working across the molecular/physiological/ecological divides through a principle as critical to the play of life as evolution: *regulation*—a cross-cutting and unifying theme in biology.

- Every kind of molecule, cell type, and process in the body is regulated. “Diseases,...., are mostly abnormalities of regulation, where too little or too much of something is made.”
- “The overarching theme of the book is that everything in the living world is regulated.”
- “...ecology is to planetary health what molecular biology is to human health—the critical knowledge to building a better future”
- This is where we come in.



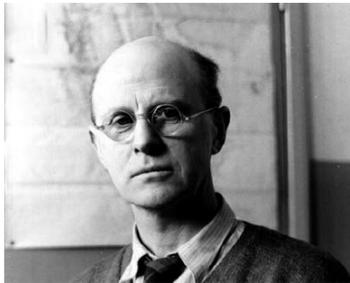
Sean Carroll (Images Source: <http://seanbcarroll.com>)

Some of Carroll's Heroes

- Walter Cannon – Homeostasis & regulation of the body
- Charles Elton – Regulation of Arctic food webs
- Robert Paine – Regulation of the intertidal by keystones
- Tony Sinclair – Density-dependent regulation of large herbivores in the Serengeti
- Stephen Carpenter and James Kitchell – Regulation of trophic cascades in Lake Mendota



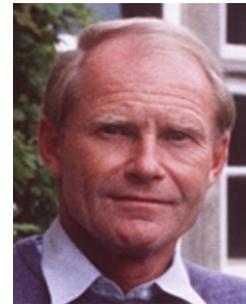
(Source: Wikipedia)



(Source: ResearchGate)



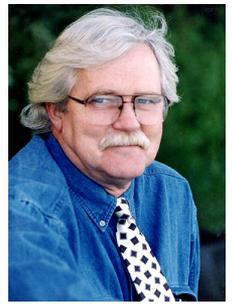
(Source: NY Times)



(Source: U. B.C.)



(Source: U. WI Madison)



Some Rules of Ecological Regulation

- Positive Regulation: Bottom-up regulation of higher trophic levels (e.g., larger animals regulated by food supply; climate a factor here)
- Negative Regulation: Top-down regulation by predators, pathogens, competition (e.g., smaller animals regulated by predators)
- Double-negative Logic: Trophic cascades (e.g., A has strong indirect effect on C by regulating B)
- Feedback Regulation: Density-dependent regulation (e.g., growth rate declines as population increases)
- Migration: Increases animal numbers by increasing access to food (decreasing bottom up regulation) and getting away from predators and competition (decreasing top-down regulation)

Where To?

- Failed ecosystems are the result of too much or too little of something (e.g., HABs, pest outbreaks, elk in Yellowstone, etc.)
- Going from distribution to abundance: “Just as there are rules that regulate the numbers of different kinds of molecules and cells in the body, there are ecological rules that regulate the numbers and kinds of animals and plants in a given place.”
- “In the body, the key ‘players’ are molecules that regulate a process. To intervene in a disease, we need to know what players are injured or missing or what rules of regulation have been broken. The task for biologists is to identify the important players in a process, figure out the rules that regulate their action, and then design medicines that target the key players.” [Back to Shakespeare]
- “We need to know the key species in any given community and the rules that govern their interactions with other species.” “...target what is broken or missing”
- We can escape the “near infinitude of particulars which have to be sorted out case by case” that can paralyze biologists and ecologists.

The Century of Biology

From Description to Prediction

(photos source: Wikipedia)



BOYLE



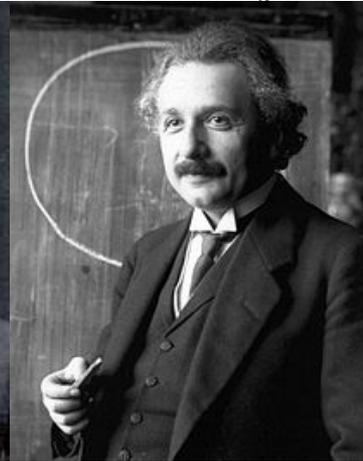
LAVOISIER



FARADAY



RUTHERFORD



EINSTEIN



BOHR

Biology is coming into its own in the 2000s in going from a largely descriptive to a predictive science but its progress is contingent on understanding *biodiversity*: the key to unlocking the doors to all levels of biological discovery.

Carroll: “among all the natural sciences, biology is central to human affairs”

“Better Living through Ecology”

- Catching walleye and northern pike in Lake Mendota in clear waters
- Willows and beavers and everything else in Yellowstone
- Greg Carr, E.O. Wilson et al. and restoring Gorongosa National Park
- William Foege and the eradication of smallpox
- We can now restore the planet with Nature rather than in spite of Nature, i.e., with trees and soil rather than concrete and steel (essentially, our two options)
- Let’s get back to the play—before it’s too late.

A Global View Makes All the Difference



(Source :NASA/NOAA/GSFC/Suomi NPP/VIIRS/Norman Kuring)

Still the Fortunate Ones

“Fellow-citizens, *we* cannot escape history.... We -- even *we here* -- hold the power, and bear the responsibility...We shall nobly save, or meanly lose, the last best hope of earth. Other means may succeed; this could not fail. The way is plain, peaceful, generous, just -- a way which, if followed, the world will forever applaud, and God must forever bless.”

Abraham Lincoln – Annual Message to Congress, December 1, 1862

Now, we are the last best hope of Earth.

Thank You