



## Exploring Keystone Species

### Purple Sea Star

#### VIDEO CLIP: Green World Hypothesis

[SEAN CARROLL:] Professor Fred Smith asked his students a seemingly simple question.

[ROBERT PAINE:] And he said “Class, I want you to think about this. Why is that tree green?” And someone said...

[STUDENT:] Chlorophyll.

[PAINE:] Fred said, “What keeps the leaves there?”

[CARROLL:] Although technically, chlorophyll is what makes trees green, Fred Smith was asking a bigger question. He was thinking about food chains.

[PAINE:] You obviously had producers. They are the energy suppliers to whatever lives off of them. And you have consumers on top of that. And we know the herbivores.

[CARROLL:] The popular idea at the time was that the number of producers limits the number of herbivores. In turn, the number of herbivores limits the number of predators that feed on them. Every level was regulated by the amount of food from the bottom of the food chain going up.

But this view didn’t explain why herbivore populations don’t simply grow to the point where they eat all the leaves on the tree. Professor Smith had discussed this conundrum with two colleagues: Nelson Hairston and Lawrence Slobodkin. They proposed a new idea. The number of herbivores must be controlled not only from the bottom up, but also from the top down.

[PAINE:] The herbivores had the capacity of destroying the plant community. Trees could be defoliated. And why weren’t they defoliated? And the answer was because there weren’t enough insects around to do that. And that was the role of predators.

[CARROLL:] The world is green because predators keep herbivores in check. This was a radical concept that became known as the “green world hypothesis.” Up until that time, no one thought predators had any role in regulating ecosystems.

[PAINE:] His class was the first public vetting of the green world hypothesis.

[CARROLL:] And one of Smith’s students, Robert Paine, would be the one to put this idea to the test.

### Blue Crab

#### VIDEO CLIP: Salt Marsh Experiment

[BRIAN SILLIMAN:] So what I had read in the literature told me this marsh plant system was controlled from the bottom up. But given my field observation, I wondered if the marsh grass was instead controlled by the snails eating it. In other words, from the top down. Working with students and postdocs in my laboratory, we designed a number of experiments to test this hypothesis.

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We set up comparison plots in the marsh. To test bottom-up effects, we added nutrients to some of the plots and not others. And to test top-down effects, we set up plots with and without snails.

One of the things we need to do is we need to add nutrients. So our ingredients for this part of the experiment are fertilizer, pantyhose, and then put it into the centrifuge tubes to be put into the marsh. We're going to weigh it. Then we're going to wrap it and stuff it. So these are the fertilizer stakes that we made in the lab for the nutrient addition treatments.

To manipulate the presence of snails in our plots, we use exclusion cages. They're one meter squared, roofless corrals made of hardware cloth and tomato stakes as corner anchors that keep the snails out. In this experiment, we place them in the marsh for six months. We'll pull all the snails out of that cage and look at how plants respond to both of those treatments.

### Mound-Building Termite

#### VIDEO CLIP: How Termites Enrich Ecosystems

[CORINA TARNITA:] So termites build these huge, huge mounds. And inside the mound, there's a great deal of activity that's going on. So termites go out. They forage for plant material, which they find in actual plants or litter or animal dung. They bring back that plant material to the nest. They break it down. They eat it. And in the process of doing that, they produce a lot of nutrients in the form of this nitrogen and phosphorus.

Also, as a consequence of their active movement, they churn the soil a lot, allowing for water to infiltrate much better and for the soil to stay a lot more moist. And so because of both added nutrients and increased water availability, plants are doing really well on the termite mound. So wherever you have termite mounds, the plants are going to get a boost in that region.