New research shows that salinity plays a major role in salt marsh grass's response to insect grazing

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The Living Coast Discovery Center and Sweetwater Marsh, as seen from the marsh's tidal zone. Credit: San Diego State University

Twenty years ago, biologists Kathy Boyer and Joy Zedler, then researchers at San Diego State University, speculated that too many insects feeding on cordgrass in the marshes of San Diego Bay could endanger the grass, and in turn endanger the bay wildlife that relies on it.

Picking up where Boyer and Zedler left off, SDSU biologist Jeremy

Long is currently further exploring the dimensions of this relationship. What he's found so far suggests that it's not a simple as saying too many insects spell death for a host plant. Instead, his research suggests a complex interplay between insects, plant growth, and the overall stress of the marsh environment.

Knowing more about how these organisms interact could help conservationists protect endangered species, lead to healthier manmade marsh environments, and give ecologists a glimpse into what climate change could mean for the marsh's future.

Urban nature

Sweetwater Marsh, toward the southern end of San Diego Bay, is a study in the dualism of an urban nature preserve. Towering tankers block the horizon behind a vast field of cordgrass and pickleweed. Egrets and herons soar overhead, as do airplanes and helicopters. A five-minute drive will put you in downtown San Diego, but a five-minute walk toward the bay will put you ankle-deep in tidal sludge, filled with snails, sponges, and sea squirts.

A number of endangered plants and animals call this salt marsh home. One of them is the light-footed clapper rail, a cinnamon-and-gray, long-legged wading bird that lives only in Southern California and the northern Baja Peninsula. This bird makes its nest in the marsh's shallow slush, forming its home with strands of the California cordgrass, Spartina foliosa. The nests float and bob with the rising and lowering of the tides.

Another marsh creature relies on the same cordgrass: Haliaspis spartinae, otherwise known as scale insects. These pinhead-sized insects form white, protective armor that allows them to live and feed for their entire lives on a single blade of cordgrass.

Funded by a grant from California Sea Grant, Long set out to discover exactly how these scale insects affect the growth of cordgrass.

Concentrating on cordgrass

For his study, Long and Laura Porturas, then an undergraduate research assistant at SDSU, conducted three experiments on the marsh. First, they visited the marsh once a week and used toothbrushes to remove scale insects from cordgrass in a particular cropping. They let the scale insects go about their usual business on another set of plants. After 20 weeks, they compared the normally-infested plants with the brushed-off ones.

"We saw major negative effects from the scale insects," Long said.

Plants with scale insects were shorter, weighed less, and died off earlier in the season than did the brushed-off cordgrass. This makes sense, Long said, as scale insects sap the cordgrass of sugars and nutrients.

But he was curious whether another factor might also be at play: soil salinity. Saltiness is a constantly churning variable in a salt marsh, and plants like cordgrass have to expend energy filtering and excreting the salt.

So he performed a second experiment in the lab, growing the cordgrass with and without scale insects in either fresh water or seawater. To his surprise, the freshwater cordgrass actually grew taller when it was infested with scale insects than when it wasn't.

Long was initially puzzled. Why did these insects appear to help the cordgrass grow in fresh water but not in salt water? Then he had an idea.

Compensating for consumption

"There's an idea in plant biology called the 'compensatory continuum hypothesis' whereby plants can compensate for grazing by growing more, but this ability changes with environmental stress," Long said.

As for why the cordgrass seemed to overcompensate in fresh water but not in seawater, Long thought that perhaps the effort required to filter the seawater was just too much for the cordgrass, stressing it too much to overcompensate. In the absence of this stress, overcompensation kicked in.

"We hypothesized that when these plants aren't stressed, they can compensate for their grazing [by scale insects] by growing more," Long said.

To test this, Long conducted a third experiment. Back in the salt marsh, he raised the salinity of select locations of cordgrass by adding locally sourced salt, then repeated his toothbrush experiment in these locations, brushing off the insects from some plants but not from others.

He found that once the salinity got high enough, it negated the positive effects of removing the scale insects. In other words, once the water gets too salty, it doesn't matter whether there's an insect infestation or not; the plant grows the same either way.

Salt of the earth

Putting the results from all three experiments together, Long concluded that salinity is a key factor in whether scale insects positively or negatively affect the growth of cordgrass. Long and Porturas published their findings this week in *PLOS ONE*.

"These plants are always trying to deal with infestation by overcompensating and growing more," he said. "But when the plant gets

too stressed by the salt, it doesn't care about the insects anymore."

That's important information for ecologists and wildlife officials who manage the marsh, as well as for future efforts to build manmade salt marshes. Also, as climate change raises the sea level, the marsh might see its natural salinity level increase.

The health of cordgrass is important to more than just clapper rails, Long emphasized. It's a critical environmental element for all of us.

"This plant provides a bunch of functions," he said. "It helps to capture carbon dioxide. It prevents erosion. It serves a buffer for river flow into the ocean. It's really the engineer of its ecosystem."

Provided by San Diego State University

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