# SHORELINES

NEWS FROM THE SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER

Smithsonian Environmental Research Center

Summer 2010

On the lookout for invasive species, Greg Ruiz, Ian Davidson and Gail Ashton prepare to survey the hull of a barge in Ketchikan, Alaska.

Photo: Monaca Noble

# CHANGES IN LATITUDE: SERC's GLOBAL REACH

SERC research extends far beyond our home base on the Chesapeake Bay. Our scientists use comparisons across latitude to test the effects of atmospheric, climatic and biological gradients. A few examples illustrate the diverse assortment and importance of SERC projects covering the planet.

Pat Neale measures changing levels of ultraviolet radiation in sunlight – UV-B, the cause of sunburn and skin cancer – in response to variations in the ozone layer of the upper atmosphere. Ozone screens out much of the sun's UV-B. Neale is interested in the effects of UV-B on phytoplankton – the tiny plants at the base of the ocean's food web. With SERC's meteorological tower, he records the UV-B hitting Maryland's temperate latitudes. The data provide the world's longest record of UV-B impacting the Earth's surface – 35 years. The ozone layer at the South Pole is much thinner than at other latitudes, forming an "ozone hole," which exposes organisms to harmful UV-B rays. Neale has served as chief scientist on oceanographic cruises measuring the impacts of increased UV-B on plankton in Antarctica's Southern Ocean.

SERC's expertise extends to the tropics as well. Candy Feller is a leading expert in mangrove ecosystems, the crucial forests protecting tropical shorelines. She has developed an experimental network to examine how mangroves take up nutrients running off the land and buffer seagrasses and coral reefs from pollution. Feller's experiments extend from Smithsonian facilities in Florida, Belize and Panama, to sites in Australia and New Zealand.

Candy Feller pauses under the roots of a *Rhizophora mangle* (red mangrove) tree on the Pacific Coast of Panama.

Photo: Anne Chamberlain

Greg Ruiz measures how marine invasions vary in an array of 30 bays and ports extending from the Aleutian Islands to Panama along the West Coast, and from Newfoundland to Panama on the East Coast. He is testing how invasion rates respond to the gradient of increasing biodiversity from the poles to the tropics. He is also testing how invasive species respond to changes in transport mechanisms, such as ships transiting the Panama Canal or up the inland passage of Southeast Alaska. Ruiz's array of sites provides a unique baseline to test if marine invasions increase during major ecological disturbances. For example, they encompass four major bays of the Gulf of Mexico, allowing measurement of biodiversity responses to the recent oil spill catastrophe.

In the 21st century, scientists must think globally. Neale, Feller and Ruiz are just three of SERC's planet-trekking ecologists. From the poles to the tropics, we are seeking solutions to the world's environmental problems.

- Tuck Hines,
Director

SERC photobiologist Pat Neale's collaborators gather phytoplankton samples in Antarctica's Ross Sea for a study exploring the impact of UV-radiation on photosynthesis.

Photo: Pat Neale

# Nitrogen Pollution Alters Global Change Scenarios From the Ground Up

## Excess nitrogen favors plants that respond weakly to rising $CO_2$

As atmospheric carbon dioxide levels rise, so does the pressure on the plant kingdom. The hope among policymakers, scientists and concerned citizens is that plants will absorb some of the extra $CO_2$ and mitigate the impacts of climate change. For a few decades now, researchers have hypothesized about one major roadblock: nitrogen.

Plants build their tissue primarily with the $CO_2$ they take up from the atmosphere. The more they get, the faster they tend to grow—a phenomenon known as the "$CO_2$ fertilization effect." However, plants that photosynthesize greater amounts of $CO_2$ will also need higher doses of other key building blocks, especially nitrogen. The general consensus has been that if plants get more nitrogen, there will be a larger $CO_2$ fertilization effect. Not necessarily so, says a new paper published in the July 1 issue of *Nature*.

"The study underscores the importance of considering the mix of species when you're trying to predict how terrestrial ecosystems will react to global climate change factors."

Adam Langley and Pat Megonigal, two ecologists at the Smithsonian Environmental Research Center, conducted a four-year study on plants growing in a brackish Chesapeake Bay marsh. In 2006 they began feeding sedge-dominated plots a diet rich in $CO_2$ and nitrogen. Just as atmospheric $CO_2$ levels are rising, so is nitrogen pollution in estuaries due to farming, wastewater treatment and other activities. Because the sedge has previously shown a large $CO_2$ fertilization effect, Langley and Megonigal expected that adding nitrogen could only enhance it.

The sedge, *Schoenoplectus americanus*, initially reacted as expected. However, after the first year something unanticipated happened. Two grass species that had been relatively rare in the plots, *Spartina patens* and *Distichlis spicata*, began to respond vigorously to the excess nitrogen. Eventually the grasses became much more abundant. Unlike sedges, grasses respond weakly to extra $CO_2$ and do not grow faster. Thus, the nitrogen ultimately changed the composition of the ecosystem as well as its capacity to store carbon.

The experiment unfolded on the Smithsonian Global Change Research Wetland, located on the Chesapeake's western shore in Maryland. The Smithsonian site has a history of climate change research that dates back to the 1980s. For this study, Megonigal and Langley placed 20 open-top chambers over random plots of plants. The chambers were 6 feet in diameter and had 5-foot-tall transparent plastic walls.

The large, plastic pods allowed the scientists to manipuate $CO_2$ concentrations in the air and nitrogen levels in the soil. Half of the plots grew with normal, background $CO_2$ levels; the other half were raised in an environment with $CO_2$ concentrations roughly double that amount. Similarly, half of the chambers were fertilized with nitrogen and the other half were untreated.

Langley and Megonigal began and ended each growing season with a census of the plants in each chamber. They noted the individual plant species, measured the above-ground biomass and the root growth. In the chambers that received the high-nitrogen diet, the plant composition changed dramatically; it went from 95 percent sedge in 2005 to roughly half grass in 2009. "It's a fact that not all plants will be able to respond optimally to all changes," said Megonigal. "The things they do respond to reflect their strategy for making a living in the environment."

"The study underscores the importance of considering the mix of species when you're trying to predict how terrestrial ecosystems will react to global climate change factors," said Langley. Rising $CO_2$ levels will favor some plants and excess nitrogen will favor others. This lesson will be important to understand as scientists consider additional global change factors such as precipitation, temperature and, in tidal wetlands, sea-level rise. The plant species that gain a competitive edge under these evolving conditions will determine how ecosystems respond to global change.

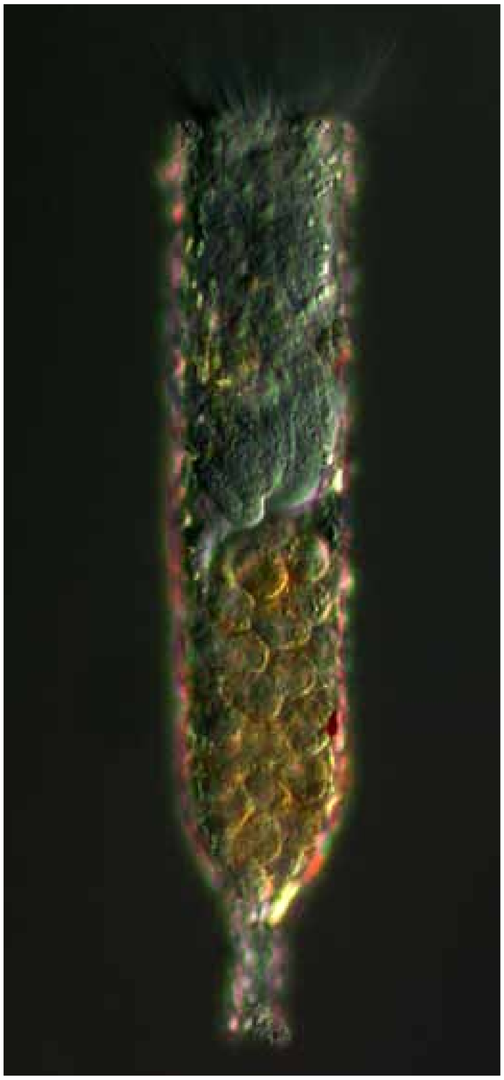
**The Citation:** Langley, J. A. and J. P. Megonigal. "Ecosystem Response to Elevated $CO_2$ Levels Limited by Nitrogen-Induced Plant Species Shift." *Nature*. July 1, 2010.

# Introducing *Tintinnophagus acutus*

In the microscopic world of marine protists, many species drift in the ocean currents unstudied and nameless. This is no longer the case for the parasitic dinoflagellate *Tintinnophagus acutus*. Plankton ecologist Wayne Coats recently finished an extensive description of the organism and thus earned naming rights.

Of the approximately 2,000 known species of living dinoflagellates, about 150 are parasitic. These organisms can alter the marine food web, in some cases destroying prey that consumers like copepods and larval fish rely upon. Coats first spotted *T. acutus* in the 1980s, in plankton samples he had collected from the Chesapeake Bay. Through his microscope, he noticed a ciliate being edged out of its lorica (shell) by a dinoflagellate. It looked different from others he had observed.

Describing a species is a serious undertaking. In the case of *T. acutus*, Coats and his collaborators documented its microscopic life cycle, conducted extensive DNA analysis and unearthed scientific papers dating back to 1873—when parasitic dinoflagellates were first noted by German scientist Ernst Haeckel.



**On the attack.** The parasitic dinoflagellate *Tintinnophagus acutus* (bottom half, yellow) consuming the ciliate *Tintinnopsis cylindrica* (upper half, blue). Photo: Wayne Coats

Much of Coats' work on this project involved understanding, questioning and clarifying various accounts of similar dinoflagellates that have been written over the years. He read studies published in French, German and English. This thorough research resulted in more than the introduction of *T. acutus*: it provided new a understanding of the evolutionary relationships among parasitic dinoflagellates and it better defined their position within the dinoflagellate lineage of the tree of life.

Protist phylogeny has never been Coats' primary focus. *T. acutus* is the second species that he has named and described. This fall Coats will retire from SERC; he says he expects to have time to describe a few more species of parasitic dinoflagellates.

The National Science Foundation helped fund this research.

***Tintinnophagus acutus***
**Translation:** Pointed tintinnid eater.

**Host Organism**
*T. acutus* is known to parasitize *Tintinnopsis cylindrica*, a ciliate found in the Chesapeake Bay during the winter months.

**Ecto or Endo?**
*T. acutus* is an ectoparasite; it attaches its peduncle (feeding tube) to the outside of its host to feed. This distinguishes *T. acutus* from other dinoflagellates that parasitize ciliates, which are all endoparasites and live inside the host's cytoplasm.

**Impact on Host**
Ciliates infected with *T. acutus* are smaller than uninfected ciliates and appear to lose their ability to reproduce. The host can survive infections, but in some cases the ciliate abandons its lorica (shell), leaving it without any protection. When this happens, the ciliate has to spend extra energy building a new lorica.

**Want to read more?**
"*Tintinnophagus acutus* n.g., n. sp. (Phylum Dinoflagellata), an Ectoparasite of the Ciliate *Tintinnopsis cylindrica* Daday 1887, and Its Relationship to *Duboscuodinium collini* Grassé 1952," by D. Wayne Coats, Sunju Kim, Tsvetan R. Bachvaroff, Sara M. Handy and Charles F. Delwiche will be published in an upcoming issue of the *Journal of Eukaryotic Microbiology*.

# Seagrasses and Sunlight

## Rethinking Water Quality Measurements

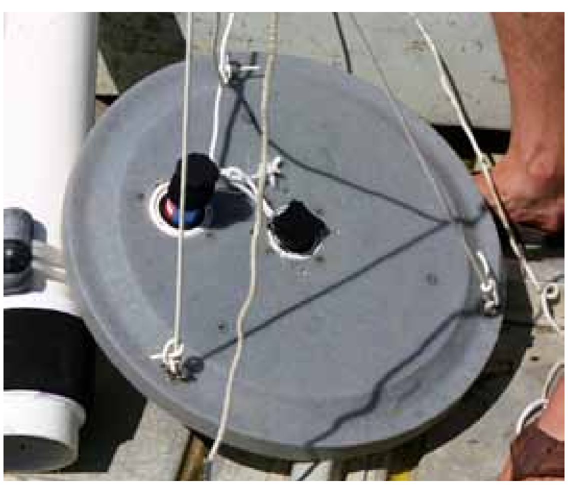
Peculiar phenomena have always brought researchers together. For SERC senior scientist Chuck Gallegos and Danish PhD student Troels Møller Pedersen, it was a mutual interest in the "carpet of fluff" that floats just above the sediment in estuaries like the Chesapeake Bay. The fluff is a soupy mix of organic and inorganic particles. These particles pose a problem to underwater vegetation because they cloud-out sunlight that the plants, particularly seedlings, need. No one has documented just how much light this layer blocks. Pedersen and Gallegos hope to change this.

Around the world, submerged seagrasses are being lost, primarily due to human activities. Scientists and resource managers are anxious to reverse the trend because the plants play a vital role in coastal ecosystems. They provide food, habitat and help filter the water. Gallegos and Pedersen think the murky fluff could impede seagrass restoration efforts. Pedersen came to SERC to quantify and potentially model the amount of sunlight that is reduced by the fluff, a measurement known as "light attenuation."

Most of Troels Møller Pedersen's research has taken place in Denmark's Roskilde Fjord. He's visiting SERC for the summer to partner with senior scientist Chuck Gallegos, an expert on hydrologic optics, the physics of how light behaves in the water.

Denmark's Roskilde Fjord is where Pedersen has done most of his research. The narrow, 24-mile passage eventually connects to the North Sea. Pedersen says its shallow waters once protected Vikings from invaders. Today's inhabitants are more concerned with eelgrass than attacks from foreign ships. According to Pedersen, Denmark has worked hard to improve water quality over the past couple decades by adopting stricter regulations on urban and agricultural runoff. While measurements of the water column show that it is cleaner, the eelgrass has not rebounded as expected.

Pedersen crossed the Atlantic to seek out Gallegos. Gallegos is an expert on hydrologic optics, the physics of how light behaves in water. The two are most interested in the spectrum of light that plants use for photosynthesis. Traditionally, scientists measure light attenuation higher up in the water column, above the layer of fluff. They then use mathematical equations to estimate the percent of sunlight that reaches the water's floor. Eelgrass, for example, grows best when around 20 percent of the sunlight that hits the water's surface, penetrates to the sediment. Gallegos and Pedersen are testing the accuracy of relying solely on the water column measurement to determine light attenuation at the sediment.



A traditional light sensor hangs from a buoy and measures photosynthetic rays higher in the water column. This sensor rests on a plate that will sink to the sediment. SERC scientists hope it will give a more accurate reading of light conditions for seagrass seedlings.

On a sunny Friday morning in June, Pedersen hops in a boat and motors to Muddy Creek, a subestuary of the Chesapeake Bay. He carries with him three main instruments: a sediment trap and two light sensors. One sensor dangles from a buoy and floats in the water column, the other sinks to the bottom of the creek, below the carpet of fluff. For the next few hours these will record light readings at ten-minute intervals. After Pedersen retrieves the instruments, he will compare the traditional way of measuring light attenuation within the water column, with the readings that the new sediment-level sensor has given him.

When Pedersen wades into the water to collect the sediment trap and sensors, he sinks knee-deep in mud. This is why he chose the creek. Pedersen is testing the light sensors along a gradient of sediments: from muddy to sandy. Back in the lab, he will analyze the sediment samples to find out exactly how much organic material is in them. Combined with the light readings, this information may help explain the time lag between water quality improvements and the reappearance of seagrass. Pedersen and Gallegos think this will yield new insight that will guide resource managers on where to focus restoration efforts for underwater vegetation.

# Bricks, Bees and Blazes

## New life comes to the Contee Farm

The Contee Farm has attracted a motley crew in recent months. Architects, archaeologists, beekeepers, construction crews and trailblazers have all descended upon the grounds. Their interest in the property varies, but they share a common purpose: to prepare the farm for visitors. In the coming years the public will be able to use the site to explore the various ways humans impact the environment.

SERC acquired the 575-acre Contee Farm in 2008. The mansion dates back to 1747 and for many decades served as a hub for the surrounding tobacco plantation. In 1890 lightening struck the house and caused it to burn. Since then, it has been vacant and left to disintegrate brick-by-brick.

The first order of business was to stabilize the crumbling chimneys. Timber support braces resembling giant tinker toys were installed on both sides of the mansion. "It was nerve-wracking," said SERC's construction manager Ray Jones. One slip and the braces could have caused the chimneys to come crashing down. A crane, a boom lift and a team of six workers successfully hoisted them up. The crew's more detailed work involved repointing the bricks with a historically accurate mortar mix made with shells.

Photo: Anna Janovicz

Photo: Peter G. Cane

In the process of stabilizing the ruins, workers unearthed an old stove and toilet, but the site's main archaeological investigations are being conducted by professionals from Anne Arundel County's Lost Towns Project. This summer a team of archaeologists and volunteers have spent most Tuesdays scooping up and surveying test-pits in a grid around the farm complex. They are trying to identify future dig sites. Archaeologist Lauren Schiszik says the Contee Farm is one of her favorite sites because of its dynamic landscape; humans have left their mark on the land from early prehistory to the present.

Three beehives sit a safe distance from the dig sites. The honeybees are the newest tenants of the farm. SERC's outreach coordinator Karen McDonald worked with collaborators from the National Museum of Natural History to build and install the hives. It is part of an effort to support the struggling pollinators whose populations have decreased significantly in recent years due to Colony Collapse Disorder.

During the flowering season, the bees feasted on the nectar and pollen from nearby wineberries, tulip poplars and trumpet creepers. Now that summer has set in, McDonald feeds them a steady supply of sugar water. She has incorporated the bees into her talks and will eventually create classes and programs around them. The larvae from the colonies will also make their way to NMNH's insect zoo.

This rich section of SERC's campus will become much more accessible to visitors next May, when the new Contee Watershed Trail opens to the public. During the past few months, education director Mark Haddon has led volunteer crews of trailblazers through the farm's woods. They have cleared fallen trees and flagged much of the two-mile route. The path will introduce hikers to the ecology, hydrology and importance of watersheds. It is one element of a multi-faceted education program Haddon has envisioned and called, "My Watershed, My Home." He says he hopes the trail will inspire visitors to explore and become stewards of their own watersheds.

The survey and restoration work has been funded in part by the Maryland Heritage Area Program and the Chesapeake Bay Gateways Network.

# INTERN SPOTLIGHT

**SERC has 34 summer interns. Meet three of them.**

## Mahil Ali

Class: 2011
Major: Biology
School: College of Notre Dame of Maryland
SERC internship: Plant Ecology Lab
In this photo: Collecting orchid roots.

## Edgar Alarcón-Tinajero

Class: 2013
Major: Anthropology and Environmental Studies
School: University of Chicago
SERC internship: Fish and Invertebrate Ecology Lab
In this photo: Surveying fish in the Chesapeake Bay.

## Moshe Roberts

Class: 2010
Major: Biology
School: SUNY-Binghamton
SERC internship: Education
In this photo: Catching frogs with campers.

# Thank You

This past May marked the end of Midgett S. Parker's term as chairman of SERC's Advisory Board. We are grateful to him for the three years he dedicated to the position. Among his many accomplishments, Parker played a leading role in SERC's conservation of the 575-acre Contee Farm. His affability, penchant for problem solving and enthusiasm for environmental research and stewardship have strengthened and guided SERC. We are fortunate that he has decided to remain on the board.

Midgett S. Parker, chairman of SERC's Advisory Board 2007- 2010.

# Your Support

Private donations help us perform cutting-edge research related to climate change, water pollution, fisheries, forest ecology, invasive species, land use and more. Your support also enables us to educate and inspire tomorrow's scientists and the public. The Smithsonian Institution is a 501(c)3 nonprofit organization. Please consider making a tax-deductible donation today.

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Smithsonian Environmental
Research Center
PO Box 28
647 Contees Wharf Road
Edgewater, MD 21037
Phone: 443-482-2200
Website: http://serc.si.edu
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Luna moth wing. Photo: Chuck Gallegos

## Upcoming Programs

**Stargazing:** The Persieds, Meteor Shower Lecture and Viewing
Friday, August 13, 7-10 p.m.

**Citizen Science:** Butterfly and Moth Collection
Saturday, September 18, 1-3 p.m.

**Hike:** Fall Orchid Walk and Talk
Saturday, September 25, 10 a.m. - 12 p.m.

To register, call 443-482-2300. To view a list of all our upcoming programs, please visit our online calendar at www.serc.si.edu.

Cover photo by Peter G. Cane.

*Shorelines* is written and edited by Tina Tennessen. Kathie Suite is the copy editor.
To send a comment, please email tennessent@si.edu.