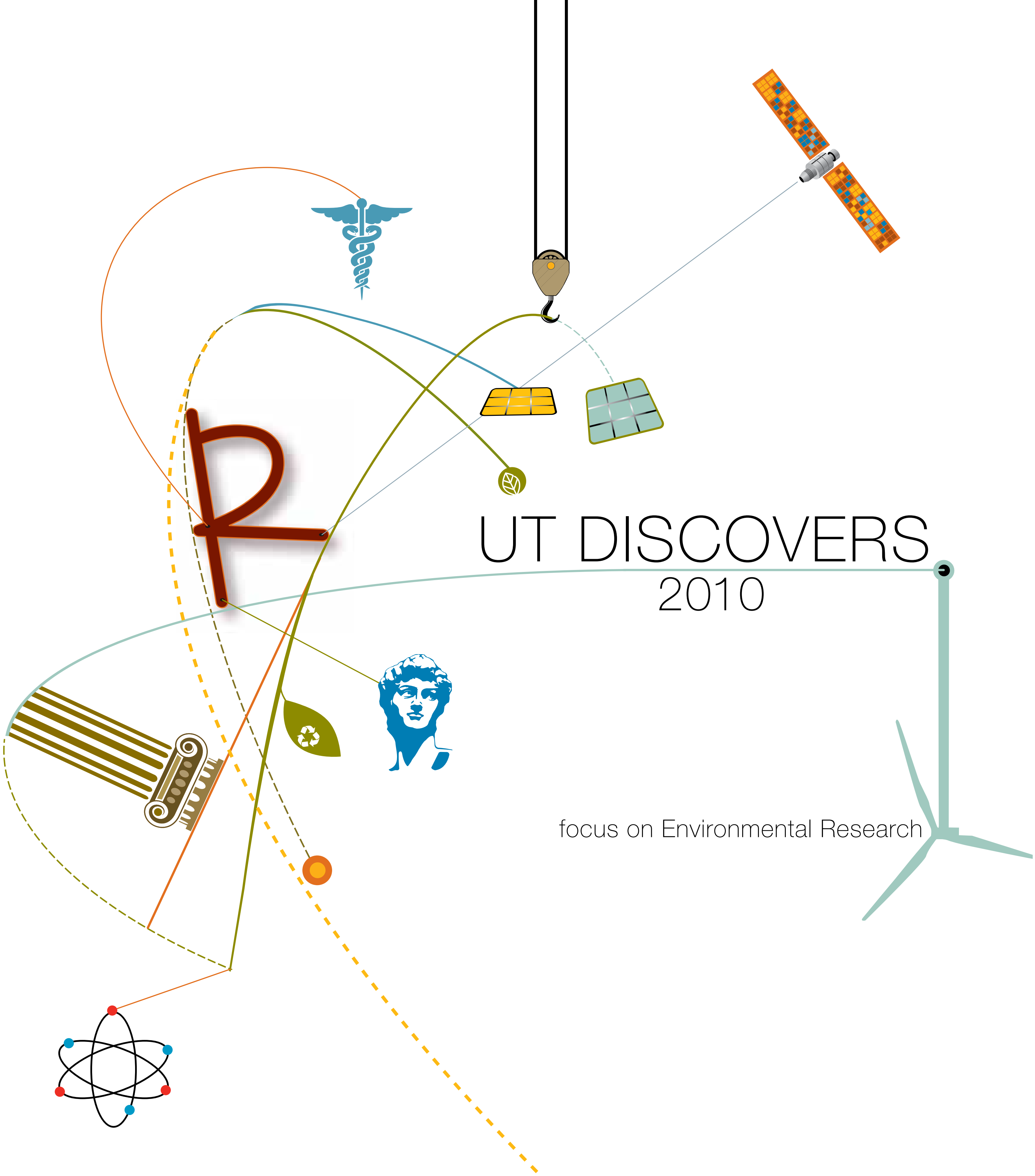

UT DISCOVERS
2010

focus on Environmental Research

THE UNIVERSITY OF TOLEDO 1872

Arctic Warming

Climate on Earth is changing, but it is not changing evenly around the globe. And the pace of climate change is happening faster at the poles. Snow melt in the Arctic is already occurring two weeks earlier than it did in 1950.

Arctic winter scene

Experimental plot

Photos courtesy of Michael Weintraub

"The magnitude of change is discouraging," says Michael Weintraub of the Department of Environmental Sciences, "and we are trying to understand the impact of changing seasons." He explains that the Alaskan Arctic is not only warming, with snow melt arriving sooner in the year, but the plant growing season is starting earlier as a result. Plants have evolved in this region to use stored nutrients for growth during the first half of the season. Then, as the soil thaws, they put down roots to collect and store nutrients for the next season.

"One reason we care about what happens in the Arctic is the simple fact that soil stores twice as much carbon as the atmosphere," Weintraub adds. Plants grow much faster than they can decompose in the Arctic, meaning that Arctic soils have been accumulating carbon for thousands of years. However, with longer thaw periods and warmer and drier soils (higher temperatures increase evaporation rates), the decomposition process will turn more carbon into atmospheric CO_2—potentially a positive feedback loop.

Mike Weintraub grew up in New York and, as an undergraduate, got a job washing dishes in a research lab. Working his way up the ladder enabled him to attend the University of California at Santa Barbara and also do research in Alaska: the best of all possible worlds.

Another piece of the puzzle involves nitrogen. It turns out that plant growth and decomposer organisms (bacteria and fungi) are limited by the amount of available nitrogen. Once plants start taking up nutrients—especially

"One reason we care about what happens in the Arctic is the simple fact that soil stores twice as much carbon as the atmosphere."

nitrogen—there may not be enough nitrogen to provide the decomposers with what they need. The time of the growing season that plants become active thus has implications for the environment, Weintraub says.

Weintraub and his colleagues have hypothesized that the growing season is divided into two phases: pre- and post-root-growth. As plants respond to a shorter pre-root-growth phase and longer root-growth phase, the implication is that the longer phase could limit decomposer activity due to nitrogen limitation. This could create a negative feedback loop limiting decomposition and the consequent release of huge amounts of carbon into the air.

But how to test this? Weintraub, his colleagues and students are mounting a huge manipulative experiment with funding from the National Science Foundation. Using giant sheets of black fabric over 8 x 12 meter plots, they are altering the timing of snow melt. They are also warming sections of these plots with warming chambers. Thus they will be able to monitor plant growth under four different conditions: earlier snow melt alone, earlier snow melt plus warming, warming alone, and no treatment.

(continued on page 72)

Clear plastic tubes—the tops have been painted white to reflect sunlight and prevent thawing—will be used to monitor plant root growth. They are placed in the ground in the marked plots, each of which is 10 x 100 meters.

Research supported by the National Science Foundation

Arctic Warming

continued from page 67

The researchers will track plant growth both above and below ground. A unique technique will enable them to monitor root growth. This system consists of a clear plastic tube with centimeter markings inserted in the ground (see photo). Once a week, a tiny camera called a minirhizotron will be inserted into the top of the tube and collect root images at precise locations within the tubes. An analysis of these images over time enables the researchers to track root growth. Additionally, an automated system that measures greenness will continuously monitor leaf growth and send the data to a data logger. At the same time, the research team will measure the amount of nitrogen available in the soil and examine how decomposing organisms are responding to nitrogen availability and changing temperatures. However, due to logistical constraints, the researchers will not be focusing on how the communities of decomposer bacteria and fungi are responding. "We are concentrating on what the decomposers are doing, not who they are," Weintraub notes. "Because a single teaspoon of soil can contain a million or more individual organisms, and tens of thousands of species of bacteria and fungi, addressing this question is another project in and of itself."

Weintraub says that additional measurements across a latitudinal gradient will help them verify experimental results and place those results in a broader regional context. An ecosystem modeler will then be able to use this massive amount of data to predict how the Arctic ecosystem will respond to the changing seasonal dynamics of plant growth and soil nutrient availability with climate change.

The Birds

continued from page 57

on the relationship between species diversity, bird predation, and agroforest production" she adds, "as well as for exploring factors that might limit insect populations."

Knowing that species diversity results in greater insect removal, Philpott and her co-workers wanted to know why—what is it about the bird community that contributes to this finding? To investigate the mechanisms behind the positive relationship between bird diversity and insect removal, the researchers looked at the functional diversity of birds. Namely, they asked, with a greater diversity of birds, do you also get a greater range of bird functions? They classified birds into functional groups based on four specific traits related to bird feeding: size, foraging habits (where and how they forage), foraging location (canopy or shrub layer), and diet. When they tallied the number of functional groups present at each research site, they found that agroforests with more species had more functional groups and that sites with more functional groups had greater insect removal rates. They also examined the possibility that the presence of more bird species increased the chances of getting a single species that is a particularly good insect eater. They found that the abundance of one species (the Tennessee Warbler) was positively correlated with insect reduction. So, it is possible that bird diversity increases insect removal because birds with different traits complement each other in the removal of insects and because of the increased likelihood of having of a single important species.

"They found that the abundance of one species (the Tennessee Warbler) was positively correlated with insect reduction."

These studies are important in several ways: they are the first to study the diversity of vertebrate rather than just insect predators in relation to ecosystem services; they include a greater range of predator species; they start to answer major questions about bird diversity and the characteristics of the bird community that relate to insect abundance. But even more, they demonstrate how research in agricultural systems and this kind of meta-analysis research can guide management practices and environmental conservation and restoration efforts.

Building New Molecules

continued from page 69

reagents such as bleach, hydrogen peroxide or even molecular oxygen with trace additives.

One of these aminoxyradical catalysts derives from camphor, a crystalline solid that consists of 10 carbon and 16 hydrogen atoms and one oxygen atom. Found in wood of the camphor laurel, a large evergreen tree found in Asia, camphor is used for its scent, as an embalming fluid and for medicinal purposes. It is a chiral compound that is abundant in nature, has a strong, penetrating, pungent, aromatic odor; and is used in the manufacture of linaments, plastics and other items. Because a chiral catalyst can recognize only one form of the substrates, Yamamoto notes, using such a catalyst speeds up production of the desired active form of the compound.

The new processes that Yamamoto is developing will contribute to cleaner, greener chemical reactions and pharmaceutical processes.

— by Jim Winkler

IR 203 0210