Environment News Futures

Asian Dust Providing Key Nutrients for California's Giant Sequoias

Researchers Find that Dust from the Gobi Desert is Providing More Phosphorus than Previously Thought for Plants in the Sierra Nevadas

28 March 2017— University of California – Riverside

The scientists found that dust from the Gobi Desert and the Central Valley of California contributed more phosphorus for plants in the Sierra Nevadas than bedrock weathering, which is breaking down rock buried beneath the soil. Phosphorus is one of the basic elements that plants need to survive, and the Sierra Nevadas are considered a phosphorus-limited ecosystem.

"In recent years it has been a bit of mystery how all these big trees have been sustained in this ecosystem without a lot of phosphorus in the bedrock," said Emma Aronson, an assistant professor of plant pathology and microbiology at UC Riverside. "This work begins to unravel that mystery and show that dust may be shaping this iconic California ecosystem." Aronson is a co-author of a just-published paper in the journal *Nature Communications* about the research. Two other scientists with UC Riverside ties are co-authors: Chelsea Carey, a former post-doctoral researcher in Aronson's lab; and Jon Botthoff, a field technician at the university's Center for Conservation Biology.

The study may help scientists predict the impacts of climate change which is expected to increase drought and create more desert conditions around the world, possibly including California. If that happens, based on these findings, scientists expect a lot more dust moving in the atmosphere, and likely bringing phosphorus and important nutrients to far flung mountainous ecosystems. Nutrients such as carbon, nitrogen and phosphorus regulate the distribution of life across Earth's surface. Therefore it is important to understand the different sources of nutrients, including underlying bedrock and wind-spread dust. Quantifying the importance of dust, which is sensitive to changes in climate and land use, is crucial for predicting how ecosystems will respond to global warming and greater use of the land.

Little is known about the role of dust in mountainous forest ecosystems, such as the Sierra Nevadas. To change that, the researchers quantified the relative importance of dust and bedrock in ecosystem nutrient supply across four sites of increasing elevation, from about 1300 to 8800 feet, in the Sierra Nevadas, just east of Merced. They then combined dust they collected with existing erosion data at the same location. They captured the dust using homemade dust collectors, which consisted of non-stick bundt pans filled with glass marbles to keep the dust from blowing out. The pans were attached to 6-foot poles to prevent dust kicked up by the researchers from entering the pans.

The researchers studied the isotopic signatures in several elements in the dust to determine the place of origin of the dust. The isotopes act a fingerprint for source of origin. The percentage of Asian dust ranged from 20 percent on average at the lowest elevation, to 45 percent on average at the highest elevation. The percentages were higher at the higher elevation sites because dust

tends to travel high in the air stream and not fall unless it hits an object, such as a mountain. The researchers found that the amount of dust from Central Valley sources was greater at lower elevations compared to higher elevations. That was expected, but they also found that more Central Valley dust was entering higher elevations later in the dry season than just after the spring rains.

"Considering we took our measurements in 2014, in the middle of the drought, this makes us think that the drought is a factor here." Aronson said. The researchers believe their findings will hold true for other mountainous ecosystems around the world and have implications for predicting forest response to changes in climate and land use.

Tiny Bacterium Provides Window into Whole Ecosystems

Ubiquitous Marine Organism has Co-evolved with Other Microbes, Promoting More Complex Ecosystems

28 March 2017—Massachusetts Institute of Technology

The many genetic variations of the tiny bacteria called *Prochlorococcus* are distributed in a layered structure, with each variant adapted to the particular mix of sunlight and nutrients found in that layer of seawater.

William Blake may have seen a world in a grain of sand, but for scientists at MIT the smallest of all photosynthetic bacteria holds clues to the evolution of entire ecosystems, and perhaps even the whole biosphere.

The key is a tiny bacterium called *Prochlorococcus*, which is the most abundant photosynthetic life form in the oceans. New research shows that this diminutive creature's metabolism has evolved in a way that may have helped trigger the rise of other organisms, to form a more complex marine ecosystem. Its evolution may even have helped to drive global changes that made possible the development of Earth's more complex organisms.

The research also suggests that the co-evolution of *Prochlorococcus* and its interdependent co-organisms can be seen as a microcosm of the metabolic processes that take place inside the cells of much more complex organisms. The new analysis is published this week in the journal *Proceedings of the National Academy of Sciences*, in a paper by postdoc Rogier Braakman, Professor Michael Follows, and Institute Professor Sallie (Penny) Chisholm, who was part of the team that discovered this tiny organism and its outsized influence.

"We have all these different strains that have been isolated from all over the world's oceans, that have different genomes and different genetic capacity, but they're all one species by traditional measures," Chisholm explains. "So there's this extraordinary genetic diversity within this single species that allows it to dominate such vast swaths of Earth's oceans." Because *Prochlorococcus* is both so abundant and so well-studied, Braakman says it was an ideal subject for trying to figure out "within all this diversity, how do the metabolic networks change? What drives that, and what are the consequences of that?"

They found a great amount of variation in the bacteria's "metabolic network," which refers to the ways that materials and energy pass in and out of the organism, along its phylogeny. The fact that such significant changes have taken place over the course of *Prochlorococcus* evolution "tells you something quite dramatic," he says, because these metabolic processes are so fundamental to the organism's survival that "it's like the engine of the system. So imagine trying to change the engine of your car while you're driving. It's not easily done, so if something is changing, it's telling you something significant."

The variations form a kind of layered structure, with more ancestral variants living deeper in the water column and more recent variants living near the surface. The team found that as *Prochlorococcus* started out living in the top layers of the ocean, where light is abundant but food is relatively scarce, it developed a higher and higher rate of metabolism. It took in more solar energy and used that to power a stronger uptake of scarce nutrients from the water—in effect, creating a more powerful vacuum cleaner but in the process also generating more waste, Braakman says. As newer variants vacuumed up nutrients in the surface layers, more ancestral types had to move down to greater depths where nutrients levels remained higher, ultimately resulting in the layered structure seen today.

The carbon compounds that make up *Prochlorococcus*' waste in turn provided nutrients that drove the evolution of another kind of bacteria, known as SAR11, whose own waste products were useful to *Prochlorococcus*, thus forming a cooperative system that benefited both organisms. The mutual recycling of waste reinforces the collective maximization of metabolic rate. "It looks like the system is in fact evolving to maximize the total throughput" of energy, not just that of individual organisms, Braakman says.

"As they optimize their ability to acquire nutrients, cells produce more organic carbon and end up promoting greater levels of mutualism," Follows adds.

That interdependent, cooperative relationship is very similar to the relationship between mitochondria and chloroplasts, the two kinds of subunits that provide the energy inside the cells of all forms of plant life, Braakman says. Chloroplasts collect energy from sunlight and use it to form chemical compounds that transfer energy to mitochondria, which can in turn release and transfer carbon and energy back to chloroplasts and the rest of the cell—through pathways very similar to those used by *Prochlorococcus* and SAR11.

Other features of the two systems are also very similar, including their photosynthetic pigments and how they deal with the detoxification of hydrogen peroxide. This suggests parallel evolutionary processes produced the same outcome in very different environments. "Plant cells really look like microscopic ocean microbial ecosystems," he explains. Partly because of those parallels, Braakman says this dynamic could potentially describe the evolution of the biosphere more generally. He suggests that the mathematical descriptions of *Prochlorococcus* evolution, which he and Follows developed together, emerge from basic principles of kinetics and thermodynamics and so could provide some insights into other systems as well. "It could be a universal kind of dynamic," he says.

"This framework can also help us model the interactions of life, sunlight, and ocean chemistry at the ocean scale," Follows says. The metabolic evolution of *Prochlorococcus* may have had one other important effect: Through a complex geochemical cycle involving the carbon compounds the microbe produced and their interactions with iron, the bacteria may have contributed to a significant rise in oxygen in Earth's atmosphere around half a billion years ago, from very low levels up to near-modern levels. This major rise in oxygen is believed to have unleashed a rapid explosion of new species also known as the Cambrian explosion, which saw the birth of most major animal phyla.

What this analysis suggests, he says, "is what looks like a directional evolutionary process, which is steadily marching toward a direction where it's increasing the energy flux through the system. One of the consequences of that is that then oxygen ended up rising in the atmosphere, and the complexity of the ecosystem increased." A lot of evolutionary theory emphasizes competition, Braakman says, where "there are limited resources and we're all fighting for them. But what this evolutionary dynamic is saying is that it's a way of increasing the resources for the whole system, so everyone is better off. It increases total system resources."

This work, Chisholm says, demonstrates that "you really have to think about evolution at all these scales, to understand it. It's not just about a bunch of selfish genes jumping around. If you want to understand life in all its dimensions, you have to look at the genes, but also all the way up to the ecosystems. None of it will make sense if you don't look at it at all those scales."

Source: Original written by David L. Chandler.

Manufacturing, Global Trade Impair Health of People with No Stake in Either

Expert Helps Map Migration of Air Pollution Risk to Regions Far from Factories

29 March 2017—University of California – Irvine

The latest products may bring joy to people around the globe, but academic researchers this week are highlighting the heightened health risks experienced by people in regions far downwind of the factories that produce these goods and on the other side of the world from where they're consumed. Scientists quantify and map the shift of environmental and health burdens brought on by globalization and international trade.

Thermal Plants must Meet Emission Norms: Environment Ministry

31 March 2017—Vishwa Mohan – TNN

New Delhi: Sending a strong message to coal-based power plants across the country, the environment ministry has made it clear that it will neither dilute the emission norms for thermal power plants, as notified on December 7, 2015, to minimize air pollution, nor relax deadline for implementation of the stricter standards.

"The revised emission standards for thermal power plants were notified with respect to Particulate Matter (PM), sulphur dioxide (SO_2), nitrogen oxide (NO_x), mercury (Hg) and water consumption on December 7, 2015, and shall come into force from December 6, 2017," said environment minister Anil Madhav Dave.

Chinese Demand for Elephant Ivory Drops, New Report Says

29 March 2017—PTI

Nairobi: A leading elephant conservation group says the price of ivory in China has dropped as the country moves toward a ban on the legal trade of ivory this year. Experts say Chinese demand for tusks has been driving elephants toward extinction.

A report launched Wednesday surveyed the price of ivory in markets across China over the last three years and found prices had dropped from $2,100 per kilogram in early 2014 to $730 in February. Save the Elephants says factors behind the drop in the price of ivory include an economic

slowdown in China resulting in fewer people being able to afford luxury goods, and a crackdown on corruption dissuading business people from buying expensive ivory items as "favors" for government officials.

Antarctica's Temperature to Rise by 3 Degrees by End of Century

An Expert Said the Rise in Temperature could be the Tipping Point as far as the Fight against Global Warming is Concerned

14 July 2015—IndiaToday.in

Delhi: The temperature in Antarctica may increase as much as three degrees by the end of the century, according to an expert. This could be the tipping point as far as the fight against global warming is concerned, he added. "There are models about the kind of increase in (temperature in) 21st century in Antarctica and it is suspected that the temperatures in the Antarctica peninsula could increase about three degrees up to the end of this century," Jeronimo Lopez-Martinez, president of the Scientific Committee on Antarctic Research (SCAR), told IANS on the sidelines of the XII International Symposium on Antarctic Earth Sciences here.

The Britain-based SCAR is responsible for initiating, developing and coordinating high quality international scientific research in the Antarctic region (including the Southern Ocean), and on the role of the Antarctic region in the Earth system. Martinez also said that there was clear evidence that global warming is increasing in the planet in general and particularly in some areas.

"The areas where the temperatures have increased in the last 50 years are polar—some areas in Alaska and Siberia and Western Antarctica. The effects of warming on ice is increasing," he said, adding that melting ice changes salinity, influences currents and raises the sea level. "The complications will arise if the temperatures increase more than 2.5 degrees in the next century," Martinez said when asked if there was a tipping point beyond which the challenge of global warming would be difficult to overcome.

Nearly 400 scientists from 40 countries are participating in the Goa symposium that has a focus on the Antarctic region with a special thrust on sub-ice rocks in relation to global sea-level rise.

The atmosphere over Antarctica as well as the ocean surrounding the southern continent has strong influences on global weather patterns and ocean currents which directly affect the mankind across the globe.

(*See* Snapshot 2)

Renewables Roadshow: How Canberra Took Lead in Renewable Energy Race

In the latest in our series on Australian green energy projects, we find out how the ACT is transitioning to 100% renewable energy, aided by the country's largest community-owned solar farm.

- How the 'nonna effect' got Darebin's pensioners signing up to solar
- How Daylesford's windfarm took back the power

As Australia remains mired in a broken debate about the supposed dangers of renewable energy, some states and territories are ignoring the controversy and steaming ahead.

While Australia is far from the renewable capital of the world, the Australian Capital Territory may soon be among the world's top renewable energy regions. And as it transitions, the ACT is demonstrating the benefits of the renewables boom to the rest of the country.

Climate Change: Global Reshuffle of Wildlife Will Have Huge Impacts on Humanity

Mass migration of species to cooler climes has profound implications for society, pushing disease-carrying insects, crop pests and crucial pollinators into new areas, says international team of scientists. Global warming is reshuffling the ranges of animals and plants around the world with profound consequences for humanity, according to a major new analysis.

Rising temperatures on land and sea are increasingly forcing species to migrate to cooler climes, pushing disease-carrying insects into new areas, moving the pests that attack crops and shifting the pollinators that fertilise many of them, an international team of scientists has said.

They warn that some movements will damage important industries, such as forestry and tourism, and that tensions are emerging between nations over shifting natural resources, such as fish stocks. The mass migration of species now underway around the planet can also amplify climate change as, for example, darker vegetation grows to replace sun-reflecting snow fields in the Arctic. "Human survival, for urban and rural communities, depends on other life on Earth," the experts write in their analysis published in the journal *Science*. "Climate change is impelling a universal redistribution of life on Earth."