## Fingerprinting fugitive dust

**Virginia Gewin**

Finding the sources that contribute to the estimated 1000 tons of so-called "fugitive dust" entering the atmosphere each year is of increasing concern. Scientists at the US Department of Agriculture's Agricultural Research Service (USDA-ARS) have shown that enzymes produced by soil microorganisms can be an effective tool in tracing the origin of dust.

The researchers generated dust in the lab, thereby knowing its exact source, which is often difficult when collecting field data. The set of three soil enzymes used as a collective fingerprint are sensitive to climate, soil properties, and management, making them perfect candidates to profile soils over an entire region.

Enzymes can also provide information about specific nutrient cycles or even organic matter decomposition. USDA-ARS soil microbiologist Veronica Acosta-Martinez (Lubbock, Texas) knew enzymes remained active in the soil for some time, but was surprised to find aryl sulfatase, typically the least predominant enzyme in these semi-arid soils, still present in the dust. "Enzymes are able to tell us about biochemical properties and the status of different soil processes", she explains.

Enzymes are the latest in a series of dust profiling tools. Past work has focused on using fatty acid methyl esters (FAME) to profile microbial communities, as well as inorganic factors to profile soil mineral and chemical characteristics. "By layering these measures together, we can get a nice idea of what the biology of a given soil looks like under different management systems", notes USDA-ARS soil microbiologist Ann Kennedy (Pullman, Washington), who developed soil FAME profiles.

By combining both organic and inorganic characteristics, the fingerprint becomes even more robust. "The more you describe a person, the easier it is to trace that person", points out Acosta-Martinez. "We're trying to do that with dust also."

Her research partner, soil scientist Ted Zobeck (Lubbock, Texas), is also working with others to develop additional profiling tools. Both Zobeck and Acosta-Martinez agree that enzymes alone can't do the job.

Zobeck is starting a project with Rich Arimoto of the Carlsbad Environmental Monitoring and Research Center (Carlsbad, New Mexico) to develop another tracing method, using radionuclides. "We're the first ones looking directly at plutonium", says Arimoto. This method has been overlooked in the past, due to the large sample size requirements and difficult analysis.

According to Zobeck, "The overall goal of using these technologies is to identify types of cropping systems that have problems with dust, and to develop strategies to mitigate dust in the atmosphere". ■

## Global warming and insect pheromones

**Leslie Bienen**

Concentrations of carbon dioxide ($CO_2$) and ozone ($O_3$), two greenhouse gases associated with global climate change, have increased by more than 30% each since the mid 1800s. Gases can affect the nutrient content of plants and thus the damage inflicted on them by plant-feeding insects. For example, caterpillars may eat larger portions of plants grown in enriched $CO_2$ environments due to nutrient dilution in the plant tissues. Such plant-mediated "bottom-up" impacts of climate change on insect herbivores are better understood than are "top-down" effects, such as how greenhouse gases mediate interactions between insects and their enemies.

Now, Ed Mondor and his fellow entomologists at the University of Wisconsin (Madison, WI) are studying how these gases may influence top-down interactions and the corresponding health of agricultural and forest plants. "Pheromones regulate insect behaviors as diverse as alarm signaling and sexual communication", explains Mondor. "We need to know if increased levels of greenhouse gases alter pheromone communication, and how the production or reception of pheromones may change as climate change progresses."

Courtesy of M Tremblay

*A colony of the aphid* Chaitophorus stevensis *feeding on an aspen leaf*.

The team's research, conducted at the Aspen Free-Air $CO_2$ Enrichment (FACE) site in northern Wisconsin, investigated how elevated levels of $CO_2$ and $O_3$ modified pheromone-mediated alarm dispersal, a defensive behavior, in the aspen-feeding aphid, *Chaitophorus stevensis*. "Aphids frequently emit alarm pheromones only when attacked, so the signal is a reliable indicator of a predator", says Mondor. "Dispersal responses to this pheromone differ, depending on atmospheric composition. When $CO_2$ was elevated, aphids did not disperse as readily. However, if $O_3$ was elevated, aphids exhibited an extreme dispersal response." The researchers think this exaggerated escape behavior may explain the larger aphid populations observed under enriched $O_3$ conditions.

In addition to the environmental disruption that altered insect behaviors and demographics could cause, Mondor notes that the team's research may indicate a need to "take a second look at how pheromones are used for pest management".

"Pheromones are fundamental to insect survival", he explains. "Understanding how pheromones and greenhouse gases interact will be vital for predicting how insect populations and the plants they eat will fare in an environment radically altered by global climate change." ■