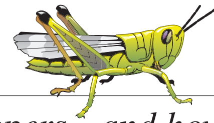
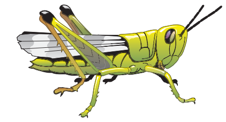
Homing In on Hopper Hordes!





ARS scientists learn more about mass migrations of grasshoppers—and how to prevent them

In a year when insects are making appearances in the millions, and even trillions—17-year cicadas disrupting daily life in the East, 3-mile-wide bands of Mormon crickets blanketing fields and roadways in the West—it makes sense that insects capable of stripping a field bare and stopping rush-hour traffic are capturing people's attention.

In some parts of the West, grasshoppers, which seem so harmless when they leap out of sight at our presence, can reach population densities that might seem supernatural.

While they're a food source for many wildlife and bird species, grasshoppers, at times, can number in the hundreds of millions in states like Colorado, Wyoming, and California. At outbreak densities, they gobble up valuable forage from rangelands used by livestock and compete with wildlife on native grasslands. Damage from the insect—which can eat half its weight in a day—can reach $390 million a year.

Grasshopper experts at the ARS Northern Plains Agricultural Research Laboratory in Sidney, Montana, believe that relief from future hopper outbreaks lies largely in taking a preventive approach. By uncovering the biology and ecology underpinning these population surges, the researchers hope to be able to reduce the likelihood and scale of grasshopper outbreaks.

They're also investigating ways to reduce the need for aerially sprayed pesticides that have historically been used to combat hopper scourges. Some of these chemicals may pose a risk for nontarget organisms, especially when applied to vast acreages. And they're not a cost-effective solution for ranchers who seek hopper control over the long term, since the cost of conventional treatment can exceed the value of the forage itself.

Hooved Helpers

Drought conditions set the stage for a population explosion because developing hoppers thrive in a warm, dry environment with patches of bare soil. These patches offer grasshoppers the perfect opportunity to bask in the sun. That's important because hoppers need energy from the sun to develop and process food, according to entomologist David H. Branson, who is with the Sidney lab. Overgrazing can further encourage these bare spots. But grazing at the right time of the year and in the right environmental conditions can curb hopper numbers by creating unfavorable habitats for them.

Building on studies begun by entomologist Jerome A. Onsager, now retired from ARS, Branson is researching how the timing and intensity of various grazing schemes affect grasshopper densities and the plant communities they depend on.

"With the appropriate grazing system, we can reduce bare soil, increase shading from plants, or control how much vegetation is removed at critical periods of the grasshopper's life cycle and decrease its development and survival rates," Branson says.

In a study using caged grasshopper populations at Miles City, Montana, with rangeland scientist Marshall Haferkamp, from ARS's Fort Keogh Livestock and Range Research Laboratory, Branson found that differently timed sheep-grazing schemes during a severe grasshopper outbreak (more than 100 hoppers per square yard) didn't have a significant effect on hopper population dynamics. That indicated that livestock grazing during severe outbreaks will not have a significant effect on grasshopper populations. "This is because the hoppers are already eating so much vegetation that grazing won't make a difference," Branson says. But during less severe outbreaks, grazing might be beneficial.

A complex matrix of factors affects whether or not grazing is the right solution to grasshopper problems. Weather conditions, grasshopper densities, and the type and composition of plant communities must all be considered. Branson is studying different grazing strategies over large areas—from 100 to 1,000 acres—to see which grazing systems reduce grasshopper problems.

Fire on the Range

Sidney researchers have turned to another force that can alter grasshopper habitats: fire.

One such fire that occurred near the Montana laboratory wasn't planned. It rolled through the U.S. Forest Service's Little Missouri National Grassland in western North Dakota in the late fall of 2001. Fortunately, it swept through an area where the researchers had already established sampling sites for another experiment.

"A year after the fire, we saw a significant reduction in grasshopper densities," says Branson. Different grasshopper

STEPHEN AUSMUS (K11435-1)

Measuring soil nutrients, plant productivity, nutritional quality, and grasshopper species composition responses to summer fire and postfire grazing, rangeland ecologist Lance Vermiere takes soil samples as technician Sue Reil clips vegetation for nutrient analysis.

species lay their egg pods at different depths in the soil. "Pods at shallow depths died, as did grasshoppers that spend the winter as nymphs. But pods laid deeper appeared less affected by the fire."

Branson and colleague Lance T. Vermeire, an ARS rangeland ecologist at Fort Keogh in Miles City, are further investigating how fire affects individual species of grasshoppers and their eggs as well as the plant communities on which they depend.

In a prescribed fire conducted in the Little Missouri National Grassland, Branson again observed a short-term reduction in grasshopper densities after the burn. But only a few of the dozen species that can contribute to an outbreak appeared to be affected.

"If a few particular species of grasshopper are dominating an area, fire could be beneficial for reducing hopper numbers," Branson says. "But we'd also have to consider the fire's effects on rangeland conditions, plant production, and ground cover."

Rangeland Recyclers

For all the trouble grasshoppers seem to cause, researchers are finding that they could be fulfilling an important function on managed rangelands, native grasslands, and prairies.

Grasshoppers digest only about 12 to 20 percent of the plant material they eat. The rest is excreted as "frass," which acts as fertilizer for the surrounding vegetation. "We're finding that in some instances, grasshoppers can improve rangeland productivity," says Branson. "It depends on what they're eating: When they feed on plants that decompose more slowly, they are able to cycle those nutrients back to the environment faster."

One long-term goal is to figure out which prevailing ecological conditions allow grasshoppers to have this desired effect. "Grasshoppers actually have very specific plant preferences, so the particular combination of plants and hoppers on rangeland plays a big role. It could be that if a rancher is facing moderate grasshopper densities—and the right rangeland conditions exist—it might be a bad idea to try to control the hoppers. In the long run, they could be doing more good than bad, especially when you consider what it costs to control them."

STEFAN JARONSKI (K11446-1)

Melanoplus **grasshoppers that have been killed by the fungus** ***Beauveria bassiana*****.**

Branson adds that during an outbreak, however, control might prove beneficial to long-term rangeland productivity.

Fungal Foes

Stefan T. Jaronski, an insect pathologist at the Sidney laboratory, studies naturally occurring microbes that can be used to suppress outbreaks of hoppers as well as Mormon crickets. The fungus *Beauveria bassiana* appears to be a strong candidate.

"*Beauveria* is like a fatal case of athlete's foot for these insects," Jaronski explains. "Grasshoppers often pick up the fungal spores on their feet—and because of the insects' open circulatory system, the fungus grows very quickly inside their bodies."

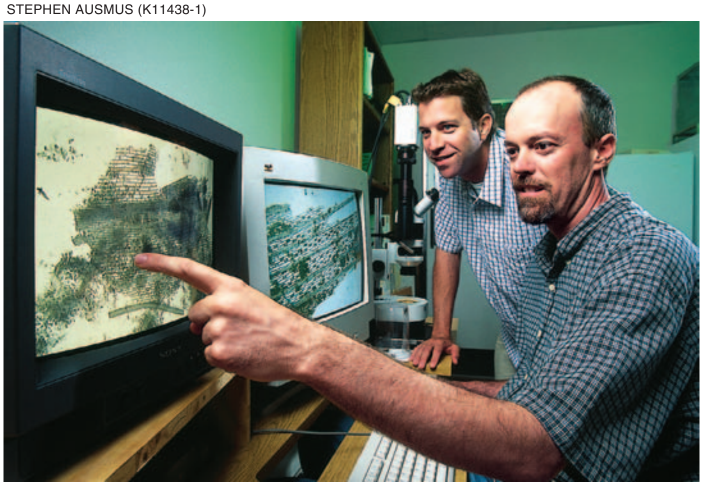
He's been investigating the efficacy of *Beauveria* in a base of canola oil, a known grasshopper attractant. But Jaronski recently found a new twist to the oil carrier.

"It turns out that raw, unprocessed canola oil, which is black and rather strong-smelling, is even more effective as an attractant than the refined, store-bought oil we've previously used," he says.

Very close to the stuff that is extracted from the seed, raw oil contains higher concentrations of the fatty acids hoppers find so irresistible. Greenhouse tests so far indicate that the oil can increase the effectiveness of the fungus. Large-scale field trials to verify these observations are being conducted by ARS along with USDA's Animal and Plant Health Inspection Service and the University of Wyoming.

Strains of another fungus, *Metarhizium anisopliae* var. *acridum,* are also getting Jaronski's attention. "It's far more virulent and specific than *Beauveria,*" he says. "It affects only insects of the group *Orthoptera,* like grasshoppers and locusts, and not honey bees, beetles, or other potentially beneficial species."

STEPHEN AUSMUS (K11438-1)



Entomologist David Branson (foreground) and ecologist Greg Sword examine images of grasshopper gut material to identify the types of plants they consume.

STEPHEN AUSMUS (K11440-1)

Greg Sword uses a computerized video tracking system to analyze Mormon cricket behavior.

Safety data have been generated by scientists in Africa and Australia who are using *Metarhizium* on locusts. Jaronski's lab tests have shown it to be highly infectious for most American grasshoppers. He's eager to study the fungal strains' effect on hoppers and is working with international scientists to bring the two promising strains into the United States for field trials.—By **Erin Peabody,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at www.nps.ars.usda.gov.

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What Makes Insects Mass and March?

Ecologist and insect behaviorist Gregory A. Sword, at ARS's Northern Plains Agricultural Research Laboratory in Sidney, Montana, wants to know why populations of certain insects periodically swell. And when they do, why do they mass and migrate?

In particular, Sword wants to discover what triggers the insects' specific movements—a sudden veer or turn or an increase in speed, for example. With this information, he may one day be able to predict the insects' trajectory enough in advance to help ranchers and others minimize their losses.

The walking habits of a lone Mormon cricket or grasshopper might seem trivial. But the cumulative effects of millions of insects walking in mile-long bands, threatening to shear off crops and vegetation, can be devastating.

Many researchers have thought that Mormon crickets—and possibly grasshoppers—behave like their cousins, migratory locusts. Locusts become more energetic when they've been reared among many other individuals. This so-called gregarious phase can lead to destructive mass-swarming.

Sword wanted to find out whether high rearing density could also explain the migrating bands of Mormon crickets that inflict damage each year in the West. After comparing crickets reared alone and those reared under crowded conditions, he found that rearing density wasn't playing a role in the movements of Mormon crickets.

STEPHEN AUSMUS (K11441-1)

A radio transmitter attached to the back of a Mormon cricket helps researchers determine its movement in the field.

"Instead, I found that their collective movement was determined by simple interactions among individual crickets within the group," Sword explains. "Lots of animals do this—schools of fish, herds of cattle. They move together as a group across their environment."

Traveling with a large crowd of individuals might appear to be counterproductive, but Sword explains that it offers an advantage. "An individual in a group has a smaller chance of being singled out and attacked by a predator than one that's alone."

Sword's study will appear in an upcoming issue of *Animal Behavior.*—By **Erin Peabody,** ARS.