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Ask a Scientist

What puts the fire in fire ants?

By Marla Vacek Broadfoot
Correspondent

Dr. Edward Vargo is a professor of entomology at N.C. State. Here he explains why summertime encounters with fire ants are no picnic. Questions and answers have been edited.

Q: *Why are fire ant "bites" so painful?*


Vargo

Fire ant stings are painful due to certain chemicals called alkaloids that kill cells they come into contact with. Fire ants are unusual in producing this class of compounds, which are normally produced by plants. Well known plant-produced alkaloids include caffeine and nicotine. Fire ants inject their venom with a sting located on the tip of their abdomen. Although fire ants do bite, the bite is largely painless and it's the sting that causes the burning sensation.

Q: *Do fire ants have the same social structure as other, less dangerous ants? What do we know about their evolutionary history?*

Fire ants originally come from South America and were introduced through human trade into Mobile, Ala., in the 1920s before spreading throughout the eastern and central United States. Most ants come in either one of two flavors of social structure: colonies with a single queen per nest or colonies with multiple queens per nest. Fire ants are unusual in that they have both social forms, and these two forms occur in North Carolina. The multiple-queen form has much higher mound density, so it supports a much larger population and therefore causes more problems. It is also harder to control since successful control of a colony requires killing all the queens – which in the case of fire ants can number in the hundreds.

Q: *Fire ants can certainly be viewed as pests, but are they good for anything?*

Many ranchers have noticed that tick and chigger populations have declined after fire ants invade an area, so they seem to do a good job of getting rid of some other noxious pests. Scientifically they have been a valuable study system for learning more about the role of ants in ecosystems and the biological mechanisms underlying the social behavior we see in ants, bees, some wasps and termites.

Q: *What is unique about fire ants?*

Fire ant queens are pretty amazing. Each queen mates with a single male and does so about 100 feet in the air during the so called nuptial flight. After mating, the queen lands, breaks off her wings and starts a colony on her own; having stored her mate's sperm in a special organ, she has no more use for the male. In a mature colony, a queen is an egg laying machine. She can lay her own weight in eggs every day – about 2,000 eggs!

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REACH OUT


Bordsen

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'They seem to keep coming'

What's worse than kudzu? A bug that eats kudzu – plus the region's soybean crop

By Amber Veverka
Correspondent

This summer, the Carolinas are experiencing invasion. Hordes of shiny, olive-and-brown bugs are blanketing fields, swarming up the sides of houses, sifting through cracks in corporate buildings, even seeping into computer servers.

They are kudzu bugs, an accidental invader from Asia, and they are covering the Southeast at a rate so rapid that that almost each week this year has brought news of yet a new county where they've been spotted.

Nightmare for farmers

What might sound like the dream insect for the South – a bug that eats kudzu – is turning into a nightmare for farmers. Since the Megacopta cribraria was first found in Georgia in 2009, it's moved on from its namesake food to devour a major crop for regional growers: soybeans.


Reisig

Dominic Reisig, N.C. State University assistant professor and extension specialist in the department of entomology, spends many of his days following North Carolina farmers around their fields, examining the damage done by the invasive bugs.

"When you go to a soybean field that has (them), it's really quite impressive," Reisig said. "They're flying everywhere as you disturb them. You do 10 sweeps of your net and your net is loaded down. They're getting into your boots and the folds of your pants."

The beadlike bugs pierce stems, drink out juices and stunt the plant. Farmers have to spray their fields several more times with insecticides to control the bug, which adds costs – financial and ecological.

"There's insects in the soybean field and when you spray, you kill all the good guys," Reisig said. "You get on the pesticide treadmill."

Damage to farm crops is mounting.

"There's a multimillion-dollar impact just in soybeans in North Carolina," Reisig said. "In the South, millions more on top of that. This year is absolutely worse than last year and I think next year will be worse than this year."

Reisig is one of a number of scientists working on a kudzu bug combat plan – a plan that involves importing another insect. The Paratelenomus saccharalis, a tiny black wasp from Japan, lays its eggs in the eggs of the kudzu bug. Scientists are conducting extensive tests to be sure the wasp won't become the next super pest, and so far the results are encouraging, Reisig said.

"This wasp, without exception, lays its eggs in kudzu bugs. We've done our due diligence; we've done our homework. ... We're collaborating with other states on this. We're really trying to do our best to eliminate the kudzu bug in a beneficial way for everybody."

That "everybody" includes homeowners, as well as farmers. Kudzu bugs coat the outsides of homes, and even if they are sprayed with insecticide, there are plenty of replacements en route.


RUSS OTTENS - UNIVERSITY OF GEORGIA

Since the kudzu bug – Megacopta cribraria – was first found in Georgia in 2009, it has moved on from its namesake food to devour regional soybean fields, invade houses and get into computer servers.


COURTESY OF ALEJANDRO DEL POSO VALDIVA

The kudzu bug neither bites nor stings humans, but the pest contains a noxious chemical that can cause caustic blisters if the bug is squished.


COURTESY OF ALEJANDRO DEL POSO VALDIVA

In their natural environment, kudzu bugs overwinter beneath tree bark – "and a big white clapboard-sided house looks like tree bark," said NCSU entomologist Dominic Reisig. The bugs also find their way into high-rises and stadiums.

"I've had people complaining about kudzu bugs all through spring and summer. They seem to keep coming," said Kathleen Kidd, biological control administrator for the N.C. Department of Agriculture and Consumer Services.

Other damage

In their natural environment, the bugs overwinter beneath tree bark, and "a big white clapboard-sided house looks like tree bark," Reisig said. "Not only do they come in your house ... they also have a noxious chemical they exude." Squish a kudzu bug and you could get orange-stained skin, caustic blisters and a nasty smell that Kidd likened to "bad body odor."

The bugs find their way into high-rises, sports stadiums, even the office. "We have had complaints from top-20 companies in the U.S. that are headquartered in North Carolina – complaints about kudzu bugs in their computer servers," Reisig said.

Meanwhile, winter – at least a Southern winter – does little to discourage the insects. "Research shows they can survive down to 20 degrees or so, and maybe colder," Reisig said. "We're not going to kill them here in the state with cold."

It all adds up to a kind of bug-mageddon. "Entomologists who are in their 70s who remember boll weevils in cotton say this kind of reminds them of that," Reisig said. "It really is overwhelming the system."

Fighting back

Researchers are continuing to search for multiple solutions. One of Reisig's students is studying soybean varieties to see whether any offer better resistance to the bugs. Kidd, of the state agricultural department, is conducting a survey to see whether any native insects might parasitize kudzu bug eggs. But most are pinning hopes on the wasp from the kudzu bugs' native Japan. Some scientists are hoping the U.S. Department of Agriculture will approve release of the wasps as early as next year.

Assuming the wasps are set loose on the South, they still won't wipe out kudzu bugs – or even greatly reduce their numbers – overnight. "We call it classical biological control," Reisig said. "And the rule of thumb is it takes about 10 years before you start seeing an impact."

The kudzu bug has a huge head start and it just reproduces very fast. Sort of like the vine for which it's named.

"The kudzu bug," Reisig said, "is the insect equivalent of a weed."

Science Briefs

» Biosensor developed for 'extreme' athletes

A new biosensor – when applied to the human skin like a temporary tattoo – can alert marathoners, competitive bikers and other "extreme" athletes that they're about to "bonk" or "hit the wall," scientists report. The study, in the American Chemical Society's journal Analytical Chemistry, describes the first human tests of the sensor, which also could help soldiers and others who engage in intense exercise – and their trainers – monitor stamina and fitness.

Joseph Wang and colleagues explain that the sensor monitors lactate, a form of lactic acid released in sweat. Lactate forms when the muscles need more energy than the body can supply from the "aerobic" respiration that suffices during mild exercise. The body shifts to "anaerobic" metabolism, producing lactic acid and lactate.

That helps for a while, but lactate builds up in the body, causing extreme fatigue and the infamous "bonking out" – where an athlete just cannot continue.

Current methods of measuring lactate are cumbersome, require blood samples or do not give instant results. Wang's team sought to develop a better approach.— EUREKALERT.ORG

» Love dark chocolate? It affects ice cream's appeal

To make the inherent bitterness of cocoa in chocolate ice cream more palatable, manufacturers add high levels of fat and sugar. Yet, bitterness is an integral part of the complex flavor of chocolate. In a study published in the August issue of the Journal of Dairy Science, investigators report that consumers who prefer dark chocolate in solid form tolerate twice the amount of bitter ingredients in chocolate ice cream than those who prefer milk chocolate. Elimination of some added sugar and fats in chocolate ice cream may be acceptable, and perhaps preferable, to some consumers.

"Our primary goal was to determine whether rejection thresholds for added bitterness in chocolate ice cream could be predicted by individual preferences for solid milk or dark chocolate," said senior author John Hayes, assistant professor of food science and director of the Sensory Evaluation Center, College of Agricultural Sciences, at Penn State. — EUREKALERT.ORG

» Magnetic pen is developed for smartphones

Sungjae Hwang, a doctoral candidate at the Korea Advanced Institute of Science and Technology, has developed a magnetically driven pen interface that works both on and around mobile devices. The interface, called the MagPen, can be used for any type of smartphones and tablet computer so long as they have magnetometers embedded in them.

Almost all mobile devices today provide location-based services, and magnetometers are incorporated in the integrated circuits of smartphones or tablet PCs, functioning as compasses.

Taking advantage of built-in magnetometers, Hwang's team came up with a technology that enabled an input tool for mobile devices such as a capacitive stylus pen to interact more sensitively and effectively with the devices' touch screen. Text and command entered by a stylus pen are expressed better on the screen of mobile devices than those done by human fingers.

The MagPen detects the direction at which a stylus pen is pointing, selects colors by dragging the pen across smartphone bezel, identifies pens with different magnetic properties; recognizes pen-spinning gestures and estimates the finger pressure applied to the pen.— EUREKALERT.ORG

Instant feedback for a lecturer

A new system lets the students in a large lecture class give instant reactions to their professor, who can scan the room to see who is following or having trouble with the lecture.

Speaker's glasses
Camera locates students in room; small digital projector shining into glasses shows the speaker feedback from each student

Students' smartphones
Application running on phone lets student say whether he or she understands speaker

What the lecturer sees
Symbol over each student's head indicates whether he or she understands or has questions
Graph shows class total (useful for large lectures)

Source: Universidad Carlos III of Madrid Interactive Systems Group
Graphic: Helen McComas

In the news

Fertilizer has a long history

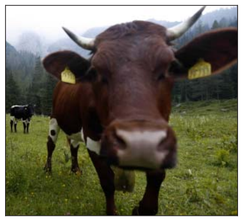
Early Europeans put manure on crops 8,000 years ago

By Michael Balter
ScienceNOW

Europe's first farmers helped spread a revolutionary way of living across the continent. They also spread something else. A new study reveals that these early agriculturalists were fertilizing their crops with manure 8,000 years ago – thousands of years earlier than previously thought.

Fertilizer provides plants with all sorts of nutrients that they need to grow strong and healthy, including (most important) nitrogen, phosphorus and potassium. That's why farmers all over the world, in countries rich and poor, put manure on their crops. Nevertheless, it may not be intuitively obvious that spreading animal dung around plants is good for them, and archaeologists had found no evidence for the practice earlier than about 3,000 years ago. Farmers in the Near East – what is today Israel, Palestine, Syria, Jordan and neighboring countries – began cultivating plants and herding animals about 8000 B.C., but there are no signs that they used animal dung for anything other than as fuel for fires.

So a team led by Amy Bogaard, an archaeobotanist at the University of Oxford in the United Kingdom, decided to look for evidence in Europe, where farming began to spread from the Near East about 8,500 years ago. Manure has a higher than normal proportion of the rare isotope nitrogen-15, which is heavier than the more common N-14. The researchers took advantage of recent agricultural research showing that plants treated with manure also have more nitrogen-15. They measured the nitrogen-15 content of plant remains from cereals such as wheat and barley and pulses such as peas and lentils from 13 early farming sites. The sites dated to between 7,900 and 4,400 years ago and ranged from Greece and Bulgaria in the southeast to the United Kingdom and Denmark in the northwest. As the team reported this month in the Proceedings of the National Academy of Sciences, the nitrogen-15 levels in 124 crop samples, totaling more than 2,500 individual cereal grains or pulse seeds, were high and consistent with the use of manure at most of the 13 sites.


MATTHIAS SCHRADER - AP

Raising crops and livestock may have developed in tandem.

Bogaard and her colleagues conclude that as agriculture spread to Europe, farmers began to invest more and more heavily in the long-term management of their fields. That meant spreading manure, which breaks down slowly and increases the fertility of farmland over many years. This long-term relationship with the land, the team suggests, fostered notions of land ownership and fueled the kind of stratified social hierarchies of wealthier and poorer peoples that other researchers have uncovered on the continent.

So how did early farmers figure out that spreading manure was a key to farming success? Bogaard said that there are several plausible scenarios. Areas of "natural dung accumulation," where animals hung out, would have provided "patches of superfertile ground that early crops would have colonized," she pointed out, adding that "subsistence farmers are extremely observant of small differences in growth and productivity among their plots." And new evidence from both the Near East and Europe, Bogaard said, suggests that "cropping and herding developed in tandem" and were "entangled from the start."

The team is on firm ground in claiming the earliest use of fertilizer, said Martin Jones, an archaeologist at the University of Cambridge in the United Kingdom. "We used to think that close integration of animal and crop husbandry" was a later development, he says, but the new research indicates "that it goes back to Europe's first farmers."

A small shift for sonic levitation

By Kelly Servick
ScienceNOW

A tragic opera may move you to tears, but here's a more literal application of the moving power of sound. Sound waves with frequencies just above human hearing can levitate tiny particles and liquid droplets and even move them around, a team of engineers has demonstrated. The advance could open up new ways to handle delicate materials or mix pharmaceuticals.


Poulikakos

Researchers have already developed several levitation methods. For example, electrostatic or magnetic fields can exert a concentrated force on an object to counteract gravity. But these fields work only on metallic substances or materials with magnetic properties. Sound waves don't discriminate, however, and physicists worked out the basic principle of "acoustic levitation" nearly a century ago. A vibrating plate generates a sound wave that bounces against another surface to create a stable standing wave. The points of lower pressure in this static pattern can trap a particle. Scientists have learned how to hold increasingly heavy particles including superdense iridium and even liquid droplets in this acoustic sweet spot.

But until now, that was pretty much the extent of the trick, said mechanical engineer Dimos Poulikakos of the Swiss Federal Institute of Technology in Zurich. "It's like we had a car which we made fancier and fancier, but it stayed parked. We were never able to drive." Moving a liquid with sound is a delicate balancing act, he said. As you vary the acoustic force to push the droplet around, you run the risk of shattering it with too much pressure.

Poulikakos' team spent four years trying to budge their floating droplets from a standstill. Finally, they conceived of a chessboard-style setup with multiple vibrating plates, each generating its own sound frequency. By varying the frequency that each plate emits, they can move the acoustic field and the object trapped inside. Their new design, described in the Proceedings of the National Academy of Sciences, can precisely control the lateral movement of liquid droplets while keeping them floating smoothly in midair. It can also move them toward one another. When two droplets are forced into the same place, they may coalesce into a single droplet or react dramatically.

In the new research, the team merges liquids with solids, dissolving coffee in a water droplet, and also uses the setup to lift and spin a toothpick. Previously, no one had been able to control objects larger than a few millimeters in diameter, said physicist Chris Benmore of Argonne National Laboratory in Lemont, Ill., who was not involved in the work. The technique is limited to objects about three times the density of water, but the team is now working to push its limits. By changing the shape of the reflecting surface to create a stronger acoustic force, they expect to move denser materials, such as steel.

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