

New ways of pest control

SENDING OUT SIGNALS TO ATTRACT INSECTS THAT EAT PREDATORS MAY BE THE WAY TO SUSTAINABLE AGRICULTURE, WRITES S ANANTHANARAYANAN

s crop plants are bred and refined for features of better yields and also to be hardy and resilient, they are losing out on a network of natural safeguards that wild plant varieties employ for pest control. Great effort, expense and damage to the environment then become necessary, for a purpose that the plants had within themselves before they got specialised.

Johan A Stenberg, Martin Heil, Inger Åhman and Christer Björkman from the Swedish Uni-

dators that leaf-eating organisms that endanger plants have appeared on the scene.

As generating VOC consumes scarce resources, plants generally produce these at the onset of damage by herbivores. "Even as humans, we smell it when our neighbour is mowing the lawn — odours can carry very precise information," says co-author Martin Heil of Cinvestav-Irapuato in Mexico. The VOCs released are of differthat generate extra floral, ie, other than in the tive features that were native to the ancestors of flower, nectars (EFN) and produce large amounts of pollen or provide shelters for predators show stronger resistance to attack by herbivores.

EFNs have also been found to impart advantages by themselves. For one, they are direct antimicrobials and immediately protect both an injured plant and its neighbours from disease. Volatile Salicylic Acid, for instance, regulates plant resistance to infection and certain forms directly inhibit growth of bacteria and fungi. This versatility of EFN action hence marks it as a valuable trait that could be induced in crop plants.

Lost protection While this kind of "bio-control" of pests is ob-



served in plants in the wild, the features seem to have been bred out in domesticated crop varieties. "Crop domestication aims to enhance the quality of plants for human use," the paper says. "In addition to yield, domestication most commonly has altered the size, taste and nutritional quality... favouring synchronous ripening, homogenous plant sizes... or other characteristics of relevance for cultivation and harvesting and traits that facilitate transport and storage... enhanced resistance to pathogens or other forms of stress represent an integrated goal in most plant breeding programmes." In the process, breeding for the trait of resistance to herbivorous pests has been neglected. The paper, in fact, cites an instance of breeders and governmental agencies having consciously preferred cotton plants that did not exude EFNs because the presence of colonies of insects on them was considered undesirable! Many of the traits that confer direct resistance to pests have been counter-selected during domestication, either because they depend on undesirable properties such as bitterness, hairiness, toughness or toxicity and, thus, reduce the quality of the consumed parts, or because they cause a yield penalty because of the metabolic costs of resistance expression. The result is that we have huge acreage under crops with high yield and resistance to drought or flooding, traits that benefit crop-eating pests as much as they help us, but without the protec-

the domesticated plants. This has encouraged efforts to put these features back into crop plants, a move towards "rewilding". But features like secretion of a range of VOCs or EFNs involve multiple genes and the trail of their being bred out, over generations, cannot be retraced. "Whereas disease resistance is frequently based on genefor-gene resistance and, thus, depends on the presence of a single and usually dominant gene, the blends of VOCs that exert biological functions are complex," say the researchers. Classical breeding strategies, like crossing, mutation, breeding by "qualitative trait loci" are hence unlikely to be successful in getting domesticated plants to regain lost capacity.

Practical bio-control of pests has thus used methods like conserving the existing population of predators, attracting them from adjacent areas, or physically releasing predators on to crop plants infested by herbivores. This approach, however, has not gone far in all areas because the carnivores tend to disperse to neighbouring ecosystems, or they may starve once the herbivores are consumed, or, if they are used as a preventive, they may need to consume the plant matter for themselves.

Artificial release of VOCs to invoke carnivores also presents problems. For one, VOCs are signals not only to carnivores but also to herbivores. The strategy may hence turn counter-productive! VOCs also have a wide range of effects on the plant, some of which may not be desirable. And, again, their function depends on a complex of physical conditions, like temperature, humidity, which a wild plant takes into account, but is still not understood for artificial use of VOCs. And finally, VOCs may call in car-

PLUS POINTS

TheStatesman

KOLKATA, WEDNESDAY 07 OCTOBER 2015

Problem plant

The invasive Parthenium hysterophorus, native to the American tropics, could hinder the fight against malaria in East



the plant is spreading fast. Researchers from the Nairobi-based International

Africa, where

Centre for Insect Physiology and Ecology and their colleagues have found that the weed can sustain the malariatransmitting mosquito Anopheles gambiae even in the absence of a blood meal. The team's results were published in *PLOS* One on 14 September 14.

In a small study, Baldwin Torto and his colleagues found that A. gambiae was highly attracted to and fed frequently on *P. hysterophorus*. While the weed can be toxic to humans and livestock, the mosquito is able to ingest the plant's poison without suffering negative effects. Researchers do not yet know why.

"This is possibly because mosquitoes are continuously being exposed to a wide range of chemical pesticides in the environment; they seem to be adapting to other toxins to ensure their survival," Torto wrote in an email.

MAINA WARURU/THE SCIENTIST

Boosting memory

For decades, researchers have known that forming memories requires that the expression and translation of some genes be upregulated in the brain. Unexpectedly,





RAlejandro de Leon courtesy: authors

versity of Agricultural Sciences and the Department of Genetic Engineering of the National Polytechnic Institute in Mexico describe in the Elsevier journal, "Trends in Plant Science", their study of how wild plant varieties are able to attract and retain insects that pose no harm but feed on species of pests that do. Even if reengineering crop plants to get back the lost function is too challenging, the researchers suggest planting wild varieties along with crop plants or spraying crop plants with the active agents that wild plants use.



dators associate odours with the herbivore involved, as an efficient defence mechanism for the plant. Then, to hold the interest of the predators that the VOC invokes and get them to stay on, many kinds of plants also exude nectar on different parts of their body. These food rewards are carbohydrate rich, which favour the nutrition needs of predators rather than herbivores and also serve to keep predators both energetic and discourage conflict among themselves, the paper says.

and the type of the attacker so that specific pre-

Numerous studies, they say, have established that wild plants generate Volatile Organic Compounds to produce odours that announce to pre-

In addition to VOC and food rewards, the paper says plants attract and maintain the carnivores (as opposed to herbivores) by providing shelter, like cavities for ants or mites, that is more often used by predators. In general, the paper says plants



Bean plant intercropped with a resistant plant variety

Bean plant with a commercial Bean plant grown resistance enhancer compound by itself

STRANGE GOINGS-ON

OSCILLATIONS DEEP WITHIN SATURN ARE MAKING RESEARCHERS QUESTION ESTABLISHED KNOWLEDGE ABOUT THE GAS GIANT,

WRITES SARAH LEWIN

nusual ripples in Saturn's rings are revealing the mysterious inner workings of the great gas giant and planetary scientists are slowly picking apart that mystery. Billions of particles race around the planet's 170,000-mile wide set of rings that are mostly water ice with a smattering of rock. The rings are full of activity, including waves that ricochet outward in spiral patterns, most caused by the gravitational pull of Saturn's 62 moons. Waves caused by these moons, which orbit outside their sphere, always travel outward. But then there's a set of waves heading inward—which means there's some-

thing moving inside, too. Most scientists' models of Saturn and other gas giants assume the planet is pretty uniform — just a large gas envelope surrounding a small, dense core that's perhaps the size of earth. But by studying the rings' waves or oscillations, researchers are finding the picture much more complicated. "The one thing that might produce this (series of waves) is that some sort of disturbance inside Saturn itself is spinning around with a period that's less than seven hours," says Phillip Nicholson, a planetary scientist at Cornell University in New York. Researchers first noticed hints of that disturbance in the 1990s,

ploring Saturn and its moons, has carefully measured how much light from individual stars shines through the rings with its Visual and Infrared Mapping Spectrometer, which allows scientists to calculate the changes in the rings' density at different locations. Researchers can pull out the patterns of ring density, in the form of waves, caused by the oscillations of mass within Saturn itself, and use those patterns to learn about the planet, like using the sounds

When Nicholson put together the series of waves caused by Saturn's movement for a 2013 paper, they



nivores when there are not enough herbivores. which would affect the fitness of the carnivore and also lead to the carnivores "unlearning" the response to the VOCs.

One way natural VOCs are used to control pests is by "intercropping" with plant species that emit VOCs to mimic herbivore damage of the main crop plant and, hence, attract, or "pull" carnivores. Or there could be plants that exude repellent VOCs to expel or "push" herbivores away to neighbouring fields. Another strategy of using artificial VOC dispensers has been refined to the "attract and reward" scheme (see diagrams), where a combination of VOCs and EFNs provide higher efficiency.

There is still much work to be done and ground to be covered, the authors of the paper say. The existence of the volatile and odour related communications network in ecology has been recognised only some 30 years ago and work on larger breeding programmes as well as new methods to leverage biological methods for viable and sustainable pest control need to be developed, they say.

THE WRITER CAN BE CONTACTED AT simplescience@gmail.com

Welcome nuclear fallout STEVE CONNOR REPORTS ON HOW THE EXCLUSION ZONE AROUND THE CHERNOBYL PLANT HAS BECOME A WILDLIFE HAVEN 'ON PAR WITH NATURE RESERVES'

he exclusion zone around the Chernobyl nuclear plant, which was evacuated in

1986 after a devastating explosion and fire, has become a wildlife haven on a par with heavily-protected nature reserves, according to scientists. A detailed survey of the huge forested area around the stricken plant has revealed that it is teeming with large animals such elk, roe deer, red deer, wild boar and wolves despite being contaminated with radioactive fallout.

The scientists found no evidence to support earlier studies suggesting that wildlife in the region had suffered from the radiation released after the 1986 Chernobyl accident that sent plumes of radioactive emissions across much of northern Europe, causing radiation "hotspots" within the exclusion zone.

Following the disaster, more than 116,000 local residents were evacuated from the zone around Chernobyl, which covers some 4,200 square kilometres, with only key construction workers and nuclear staff allowed into the site to safeguard the stricken reactors. The absence of human activity in the exclusion zone has benefited the wildlife of the region more than any possible damage it may have suffered as a result of coming into coning and forestry, are a lot worse," said Professor Jim Smith of Portsmouth University, who led the study.

The researchers used a combination of field surveys and computer models to estimate the density of animal numbers throughout the exclusion zone and found no evidence to suggest that any species of mammal had been adversely affected by the nuclear fallout. "These results demonstrate for the first time that, regardless of potential radiation effects on individual animals, the Chernobyl exclusion zone supports an abundant mammal community after nearly three decades of chronic radiation exposure," they write in their study published in the journal Current Biology.

While the numbers of elk and wild boar, for instance, were undergoing rapid decline in the aftermath of the collapse of the Soviet Union in the early 1990s, the corresponding populations in the exclusion zone were increasing, the researchers found. The population of wolves was also found to be about seven times higher than in corresponding nature reserves in the region, they said.

"These unique data showing a wide range of animals thriving within miles of a major the mouse hippocampus also has an extensive programme of genetic downregulation that is required for memory to function properly, according to a paper published on 1 October in Science. "This is a breakthrough because we are now introducing new pathways that seem to be important in memory formation," said study coauthor V Narry Kim, who studies RNA biology at the Institute for **Basic Science and Seoul National** University in Korea. "By studying these pathways, we will be able to have a much better clue in understanding memory formation and the molecular mechanisms behind it."

According to Mauro Costa-Mattioli, who studies learning and memory at Baylor College of Medicine in Houston, Texas, and was not involved in the study, "It provides a fresh concept. Essentially, not only do you need translation stimulation, but you also need translational repression."

KATE YANDELL/THE SCIENTIST

Killing bacteria

Researchers at the pharmaceutical company, Merck, have identified a new bacteria-killing compound with an unusual target — an RNA regulatory structure called a riboswitch. The team used its drug, described in Nature on 30 September, to successfully reduce an experimental bacterial infection in mice, suggesting that the molecule could lead to the creation of a new antibiotic. Moreover, the results indicate that riboswitches and other RNA elements — might be hitherto unappreciated targets for antibiotics and other drugs.

"Finding an antibiotic with a new target... has always been one of the holy grails of antibiotics discovery," said RNA biochemist Thomas Hermann of the University of California, San Diego, who was not involved in the work. "It looks like that's what the Merck group has now accomplished.'

The team's research began with the idea of finding a compound that blocks



made by a violin or a drum to determine its shape.

and Nicholson's team used more precise measurements to fully document the ring waves' structures, which reflect the oscillations of the planet within sort of like recurring Saturn quakes.

Right now, measuring those oscillations offers scientists the best possible chance to grasp what's going on inside the planet, like Saturn's internal rotation or structure, which appears to be more complicated than previously thought. "Even dropping a probe into the atmosphere would not necessarily help a lot, because the probe will only get down to a pressure of five or 10 atmospheres before it gets cooked or squashed," Nicholson says.

Saturn isn't the only astronomical body with a groove — for many years researchers have been watching the vibrations of the sun and other stars. Even earth has a hum, and scientists use whole-earth oscillations, triggered by large earthquakes, to discern what's going on inside. Enter Krono-seismology, the study of oscillations within Saturn. Nicholson and his collaborator, Matthew Hedman at the University of Idaho, chose the name because Kronos (or Cronus) is the Greek equivalent of the Roman god Saturn, a mighty Titan, whose namesake planet has correspondingly mighty rings.

Nasa's *Cassini* spacecraft, which is currently ex-

didn't quite add up. Instead of a regular pattern of vibrations all building on one another, he was seeing multiples of some waves and missing others. He says, "If Saturn were a nice big ball of liquid hydrogen and helium, liquid and gas, it really should only have one frequency associated with each of these overtones". Instead, the measurements were like a violin that plays multiple discordant tones when one string is strummed. There's "something a bit wrong with your violin, if that's the case," he says.

Jim Fuller, a researcher at the University of California, has conducted follow-up research to try to find the possible causes of the discord. "Saturn must have a layer deep down that's stably stratified," he says. "And that part is new, because the conventional models of giant planets are just convective envelopes where the materials move freely to exchange heat all the way down to their core. But what I found is that those very simple models can't explain what we're seeing in the rings."

New models of a gas giant's interior will help reveal the reasons behind Saturn's oscillations. "We're mainly waiting for theoretical developments," Nicholson says. In the meantime, the Cassini orbiter is continuing to grab detailed data that will lend greater focus to the findings.

tact with radioactive elements, the researchers said.

"It's very likely that wildlife numbers at Chernobyl are much higher than they were before the accident. This doesn't mean radiation is good for wildlife, just that the effects of human habitation, including hunting, farm-

nuclear accident illustrate the resilience of wildlife populations when freed from the pressures of human habitation," said Jim Beasley of the University of Georgia and coauthor of the study.

THE INDEPENDENT



The absence of human activity in the exclusion zone has benefited the wildlife of the region.



the bacterial riboflavin synthesis pathway. Riboflavin is an essential nutrient for humans and bacteria alike, but while humans must consume it as part of their diet, bacteria can either scavenge riboflavin from the environment or, if supplies are lacking, make their own. "We targeted the riboflavin pathway because it is specific to bacteria so you have a built in safety margin," said John Howe of the Merck research laboratories in Kenilworth, New Jersey, who led the research.

The team devised a simple but "very smart phenotypic screen", said Hermann. The researchers tested roughly 57,000 antibacterial synthetic small molecules on cultures of *E. coli* bacteria looking for ones whose killing ability was neutralised by the presence of riboflavin. "If the effect of that antibacterial was suppressed by riboflavin," he said, "then we had a good chance that the small molecule... was targeting the riboflavin pathway."

RUTH WILLIAMS/THE SCIENTIST









