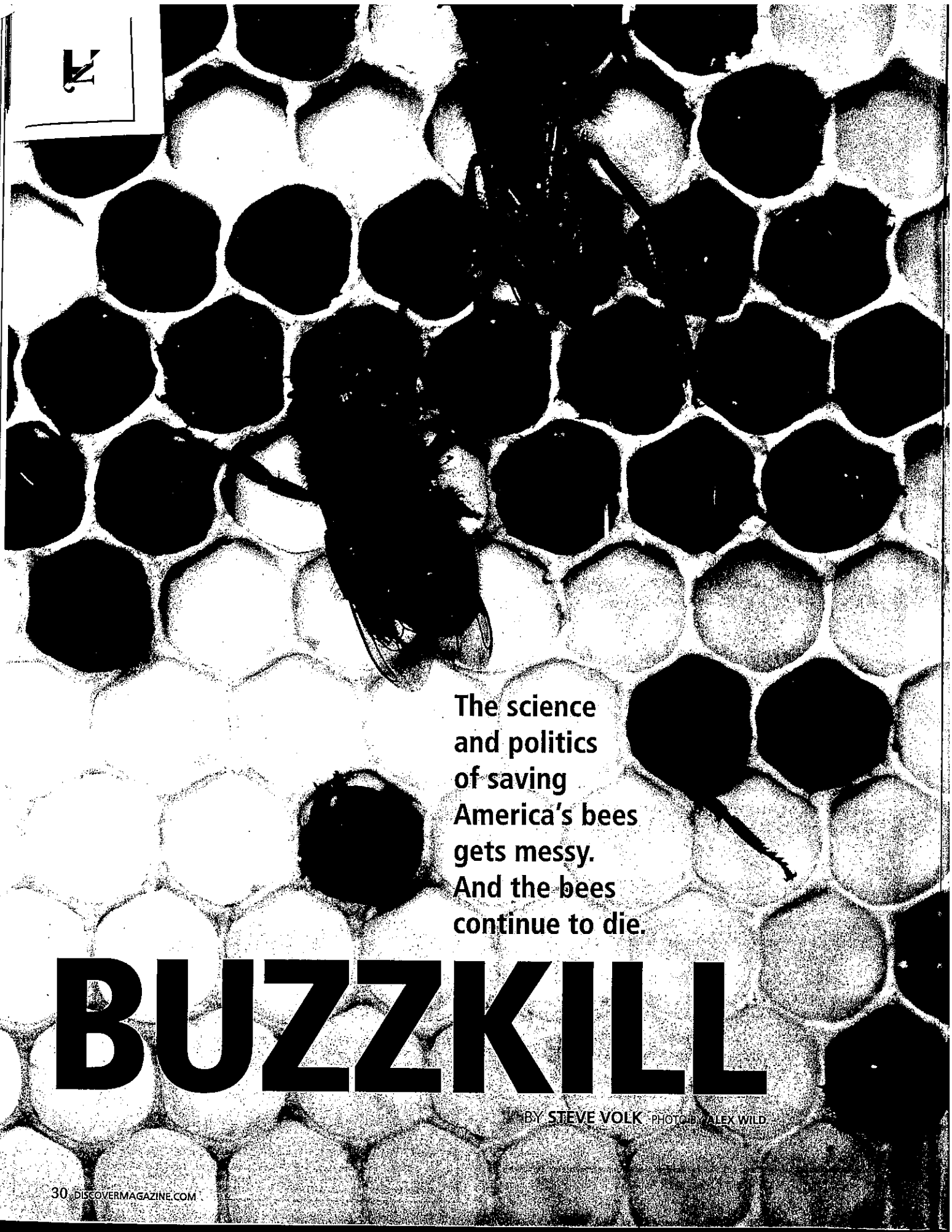
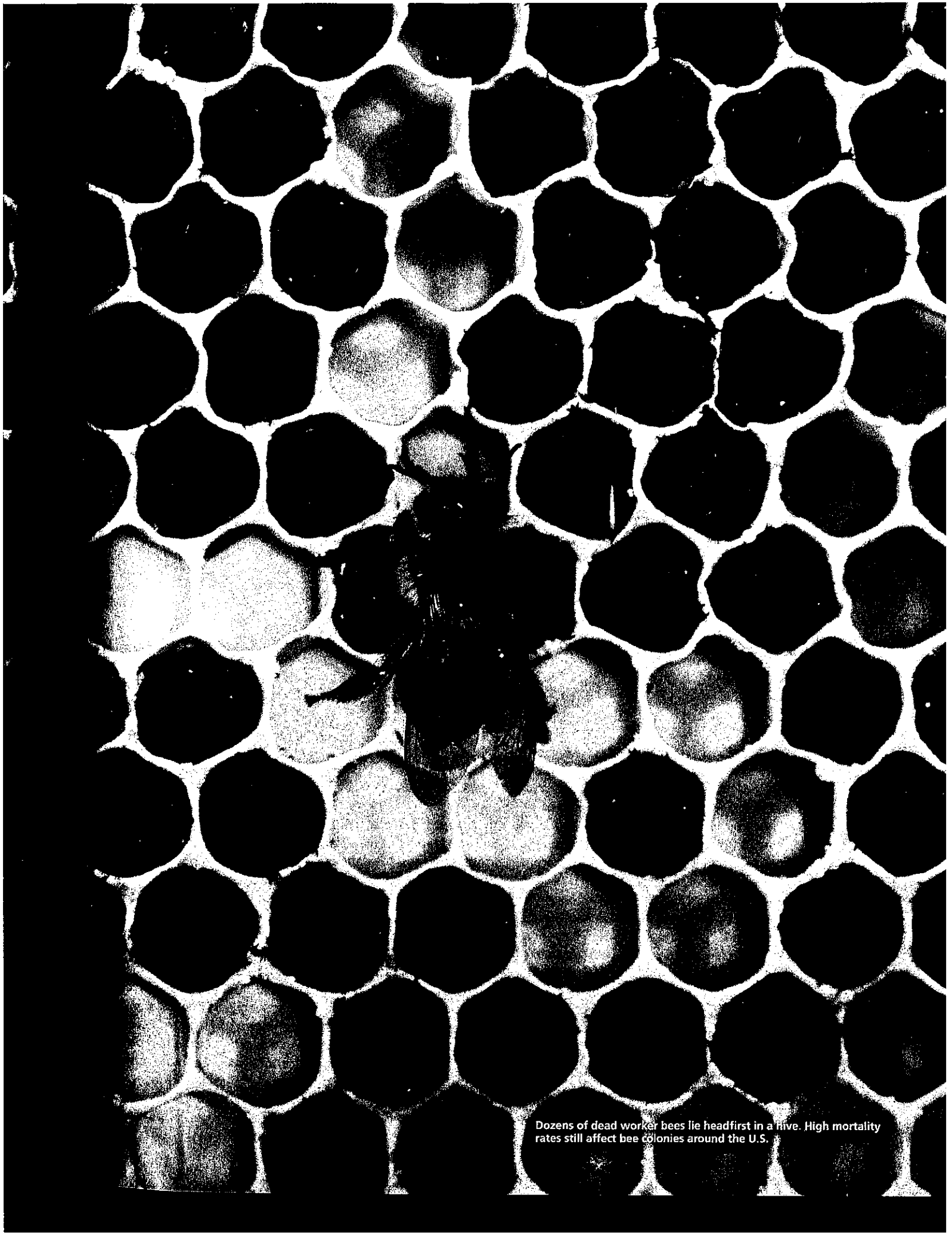


The science and politics of saving America's bees gets messy. And the bees continue to die.

BUZZKILL

BY STEVE VOLK PHOTOS BY ALEX WILD



Dozens of dead worker bees lie headfirst in a hive. High mortality rates still affect bee colonies around the U.S.

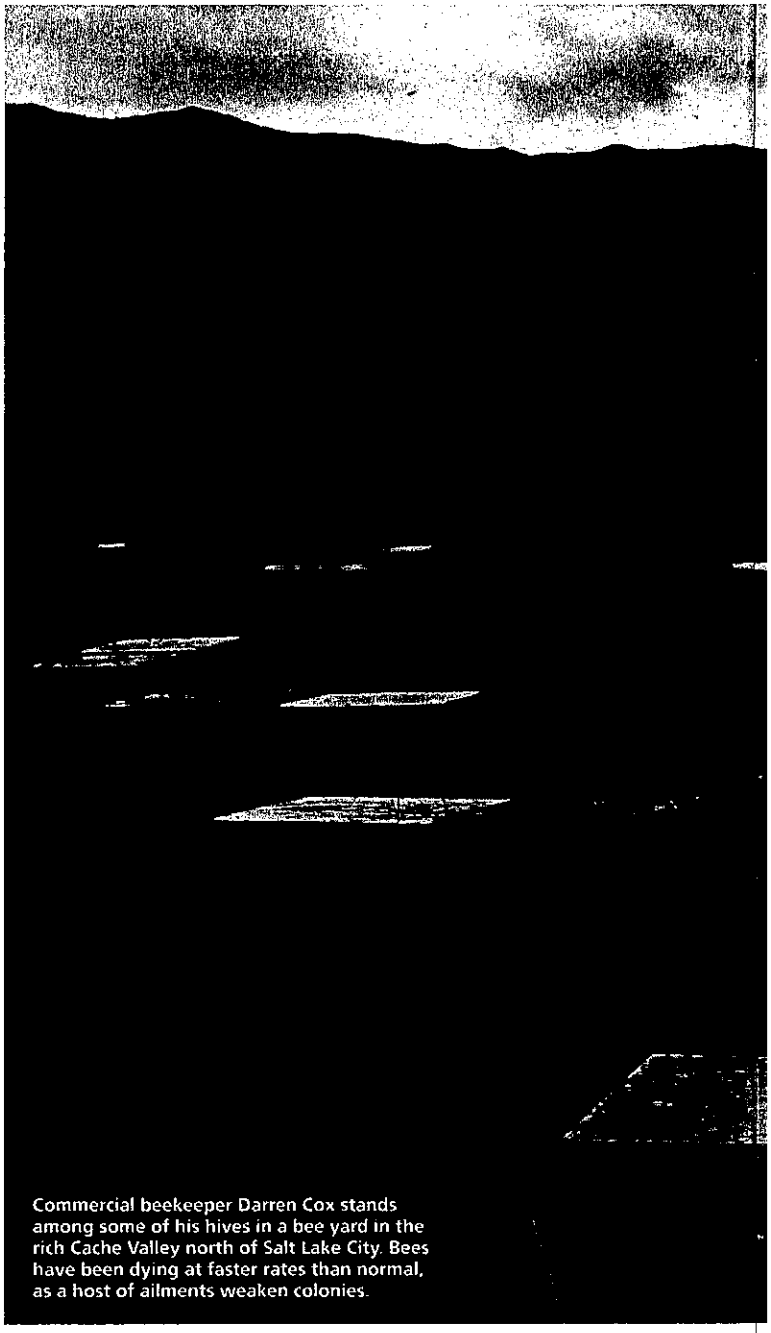
Despite all the years, and all the troubles, Darren Cox still likes to put on his bee suit.

A big, block-shaped man in his 50s, Cox sports a bowlish blond haircut and serious demeanor. But when he slips into his protective gear, his netted hat in hand, he offers a rare smile. "Time to get out there," he says.

It's a summer day in Cache Valley, an agricultural center set among the mountains of northern Utah. The skyline, composed of peaks popping with shimmering green, speaks resoundingly of life, vibrant and fertile. Several years ago, Cox and his wife built a beautiful house here, so high up that eagles soared within feet of the living room windows. But for Cox, a commercial beekeeper fighting for his livelihood, these days even his Valhalla strikes a sour note.

"When we first got here," Cox tells me, "there was so much wildlife. Fox and deer. Every bird you can imagine. You don't see wildlife like you did anymore. Where'd it all go?"

Cox keeps his "livestock" in so-called bee yards placed throughout the area. Today he'll visit them, winding through deep valleys, up tall mountains and into one of the most perplexing questions in science: What is killing our honeybees — and can we stop it?



Commercial beekeeper Darren Cox stands among some of his hives in a bee yard in the rich Cache Valley north of Salt Lake City. Bees have been dying at faster rates than normal, as a host of ailments weaken colonies.

Queen bees today barely survive a third of their normal life spans

Wild and domestic bees are both in deep trouble. Colony losses among commercial beekeepers reach 30, 40, even 50 percent or more annually, a pace that threatens the beekeeping and agricultural industries — and everyone who eats. Bees pollinate some $30 billion in U.S. crops each year, including most fruits and leafy greens, playing a critical role in human health.

The trouble started about 10 years ago, when beekeepers around the world began reporting a mysterious phenomenon: Bees that had been healthy simply disappeared, leaving no dead bodies for study. The crisis was called colony collapse disorder (CCD). And as scientific wisdom has it, the CCD crisis is over. Bees no longer just "disappear." Instead, they die at far faster rates than normal as a host of other ailments, such as deformed wing virus and deadly pathogens, exact a toll.

Cox's bees don't produce the same honey yields they did before. Queen bees struggle to survive even a third of their normal life spans, leaving beekeepers in a constant battle to replace them. According to Cox and other beekeepers, classic CCD is back, too.

In the summer of 2015, Cox showed me several hives that bore the standard

A large queen bee (left), smaller, infertile female worker bees (center), and male drones (right) all make up a functioning honeybee colony.

(LEFT) ALEX WILD

LEFT: ALEX WILD (3)

ABOVE: KIM RAFF

signs: healthy brood; good stores of pollen and nectar, or "bee food," and little else; a few straggling workers, maybe 10 percent of the population he had last week; and a big queen, running around her now-empty castle like a mom, knowing that without her stable of workers she'll be unable to feed her babies.

"Our bees are manifesting a bunch of different symptoms," Cox says as he kicks a beat-up Ford flatbed truck into gear. "Bees are dying, but what people are missing is that bees are also weakening."

As president of American Honey Producers, a trade association for beekeepers, Cox hears this from numerous members. In honeybee years, we are many generations on from the inception of the crisis, and bees themselves seem different, weaker. "They don't have as much vigor," says Cox.

For Cox and other beekeepers, the long, reasoned march of science looks more like a slow hair-pull, in which a difficult scientific problem is rendered almost impossible to resolve by the toxic influences of politics and money.

ENLIGHTENMENT AND PARADOX

In the early years of the bee crisis, beekeepers looked to science as their savior. "We believed that government, the media and, most importantly, scientists were focused," says Cox. "If a solution to this problem existed, we figured it would be found and acted on."

Ten years on, however, beekeepers have grown frustrated because the field seems stuck in the fact-gathering stage.

The reasons for overall bee declines are broadly understood: diminished bee habitat; the Varroa destructor, a nasty parasitic mite; viruses and pathogens; and agricultural chemicals, including pesticides, fungicides and insect growth regulators (IGRs). But the problem of declining bee health might actually be getting worse, largely because the factor of agricultural

chemicals lies at the nexus of science, finance and politics. Much of the controversy, and concern, has centered around a particular class of neonicotinoid pesticides (neonic for short), which yield billions in revenue for chemical-makers.

The resulting conflict is best framed, reports E.G. Vallianatos, a scientist retired from the Environmental Protection Agency, by what he calls the "Rachel Carson paradox." Carson's 1962 book, *Silent Spring*, documented the pernicious effects of agricultural chemicals and served as a rallying point for the modern environmental movement. But more than 50 years later, Vallianatos expresses disappointment. "Everyone acts like the book was responsible for a new dawn," says Vallianatos. "But did anyone actually read it?"

"Bees are dying, but what people are missing is that bees are also weakening."

Carson's argument was fundamental: Because pests and weeds quickly develop resistance, chemical pesticides create a kind of arms race. We apply increasingly toxic concoctions in greater amounts, and bugs and weeds evolve and rally.

Time has proven her right. Today we pump roughly 2.5 times more chemical pesticides, fungicides and herbicides into the environment than we did when *Silent Spring* was published. But the number of regulatory labs has decreased, leaving more chemical inputs in the environment and far fewer scientists to study them.

The standard rebuttal is that modern pesticides are better targeted toward pests. But this doesn't capture the plight of the bee, or government regulators. One of the most important papers in the field of bee declines, co-authored by then-USDA scientist Jeffrey Pettis in 2010, drew comb and wax samples from beehives in 23 U.S. states, finding an average of six different pesticides in each and as many as 39.

Numerous scientists I interviewed — from entomologist John Tooker at Penn State University, to Galen Dively and prominent entomologist Dennis vanEngelsdorp at the University of Maryland, to Pettis and others — said the number of chemicals in our environment is so vast that assessing all of their possible interactions is virtually impossible.

"Just think back to your chemistry classes," Susan Kegley, a chemist and CEO of the environmental consulting firm Pesticide Research Institute, told me. "You combine three chemicals and nothing happens, but if you introduce them in a different order, you get a big reaction. So as a scientist working on this problem of bee declines, you have to choose which pesticides, how much and the order of introduction. Then you have to acknowledge everything you might be missing if you'd changed even one of these variables, however slightly."

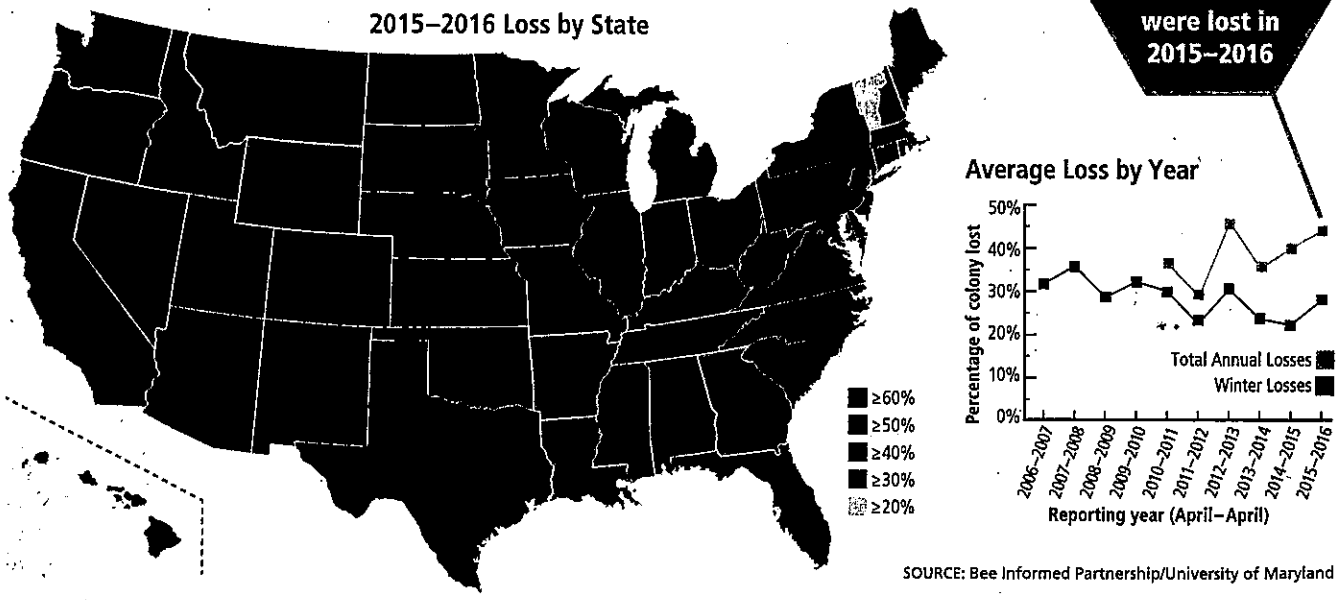
Scientists are doing what science does best: isolating specific interactions of chemical and bee in the lab while understanding they might miss important synergies among other variables. Thus far, the scrutiny has settled on one particular class of pesticide, yielding significant results. But in a development that shows just how politics creep into science, the data hasn't ruled the day. The result has been gridlock.

A COMPLICATED PICTURE

The confidence beekeepers once felt that the crisis would be resolved peaked in 2009 at Apimondia, the largest international gathering of beekeepers.

U.S. Commercial Honeybee Colony Loss

The map below shows the results of an annual survey of beekeepers and their bee colony losses. The chart tracks winter losses in the U.S. in the past decade, as well as annual losses since 2010-2011. The Bee Informed Partnership, a research consortium based at the University of Maryland, tracks mortality rates, rather than overall population, to get a more accurate sense of colony turnover year to year.



SOURCE: Bee Informed Partnership/University of Maryland

Bees pollinate some $30 billion in U.S. crops each year

A worker bee gathers nectar from a purple coneflower. Scientists are trying to figure out which factors — viruses, pesticides or a combination — weaken bees' immune systems.

Two of the world's most respected entomologists — Pettis, then research leader at the USDA's Beltsville Bee Laboratory, and vanEngelsdorp, then at Penn State — there revealed the early results of an experiment they'd just completed.

In a conversation included in the documentary *The Strange Disappearance of the Bees*, both scientists appeared visibly excited. They had looked into the danger that a widely used class of pesticides, neonicotinoids, might pose to bees.

"We're finding that virus levels are much higher in CCD bees," vanEngelsdorp says in the film, "but since we are not finding a consistent virus or a consistent pathogen, that implies that something else is happening underneath it. Something is breaking down their immune system, or somehow challenging them so that they are more susceptible to disease."

The pair fed neonics to bees, then exposed that group and a neonic-free control group to *Nosema*, a common gut pathogen in the honeybee. The bees fed neonics proved more susceptible to *Nosema*. And the effect was consistent even when bees received neonics in amounts too small to be detected in their system. "The only reason we knew the bees had exposure [to neonicotinoid pesticides]," says vanEngelsdorp, "is because we exposed them."

Beekeepers rejoiced. "They really sounded like they found something big," says Dave Hackenberg, a central Pennsylvania beekeeper. "They were like, 'This is it.'"

"We really felt confident," says Bret Adee, co-owner of Adee Honey Farms in South Dakota. "These were the guys everyone would listen to, and now we were going to get something done."

But nothing happened.

A confirming study surfaced quickly; a French team of scientists actually beat vanEngelsdorp and Pettis into print. But neonics remained in wide use. The deluge beekeepers expected — of scientists, nailing down the problem, of regulatory agencies, rushing to act — never materialized. And today, the neonic lies right at the heart of that Rachel Carson paradox.

Neonics are what's known as a systemic insecticide, meaning they spread throughout the tissue, pollen and nectar of the treated plant. Companies, including Bayer and Syngenta, create varying formulas of neonics, which can be applied to seeds or growing crops. The neonic entered broad use in the U.S. in the late 1990s and quickly became ubiquitous, used on millions of acres of corn, cotton, soybeans, canola and more, accounting for about $2.5 billion in sales.

Jay Vroom, CEO and spokesman at CropLife America, a trade partnership of seed and pesticide manufacturers, says studies measuring the effect of neonics on bees in field conditions "consistently demonstrate no negative effects."

Scientists say the picture is complicated. Regulatory agencies devote most of their energy to answering two questions: How much of a given chemical is required to kill a non-target insect outright, and how likely is it that beneficial species will encounter a dose that big? Sublethal effects are treated as less urgent, yet neonics subject bees to a variety of sublethal effects with long-term, fatal consequences.

Neonics have been demonstrated to impair the honeybee's foraging capabilities, memory and navigation systems, undermining their ability to survive and aid their hive. In one study, led by French scientist Mickaël Henry, researchers tagged honeybees with GPS trackers and released them. Some bees received a dose of neonic equal to real-world exposures while the controls received no neonics. The bees fed pesticide proved two to three times more likely to die without returning to the hive and sharing their food.

Such deaths can add up. Honeybee colonies can total tens of thousands of bees, enough to withstand natural cyclical losses. But foraging bees last only a few weeks at best. Early deaths force premature worker bees out to forage, leading to a weaker colony of weaker bees.

Worse, as Pettis and vanEngelsdorp demonstrated, exposure to neonics also appears to compromise the bee's immune system. A recent scientific literature review conducted by researchers in the U.K., Japan, France and Italy concluded that exposure to systemic insecticides, including neonics, renders bees more susceptible to numerous diseases. Further, exposure increases the mortality rate from illnesses that honeybee colonies usually shrug off.

This causal link has eluded researchers because the factors occur concurrently, according to the report. Diseases and parasites comprise the immediate cause of bee declines. Pesticides are a key underlying factor. The January 2016 paper, published in *Environment International*, identifies two popular neonics, clothianidin and imidacloprid, as disturbing immune signaling in the bee, promoting the replication of illnesses like deformed wing virus (DWV). This finding is key, the authors write, because DWV is commonly found in collapsed colonies. Immune suppression also escalates over time, perhaps eluding typical insecticide field studies.

"We're talking about synergistic effects," says Pettis.

ALEX WILD

ALISON MACKEY/DISCOVER AFTER BEE INFORMED

"Everyone wants an easy answer, a sole culprit, but neonics don't seem to be the single driver. What they are is a significant factor."

This powerful data has generated conflict, however, both inside and outside the halls of science.

WHACK-A-MOLE

"We call it the 'whack-a-mole' theory of bee science," says Hackenberg, the commercial beekeeper in central Pennsylvania. "People who stick their head too far above ground on the subject of pesticides get whacked."

This kind of talk smacks of conspiracy. However, the alignment of self-interests leaves plotting and planning unnecessary. Big agricultural companies pay many millions annually in political donations and lobbying. The politicians receiving all of this attention and money determine the dwindling budgets at agencies like the EPA and USDA.

In late 2014, EPA scientists released a study showing that neonic seed treatments produce no significant increase in crop yield. The reason is simple, even predictable: Each year, soil-based pests, targeted by seed treatments, only pop up in about 10 percent of America's cropland. But instead of dialing back pesticide use, scientists at USDA publicly rejected the EPA's findings.

In recent years, allegations of scientific suppression have grown louder. In fall 2015, Jonathan Lundgren, an entomologist in the USDA's Agricultural Research office who is now the director of the nonprofit research Ecdysis Foundation, filed a whistleblower complaint alleging that his supervisors levied a pair of bogus suspensions on him to prevent his publicizing the dangers of chemical pesticides. Attorneys for a group called Public Employees for Environmental Responsibility (PEER), an alliance of science professionals that represented Lundgren in court, alleged that an additional nine USDA scientists also sought help.

Entomologist Jeffrey Pettis, who has since retired from the USDA, was demoted two months after testifying before Congress about neonicotinoids and their effect on bee health.

In recent years, allegations of scientific suppression have grown louder.

Those scientists remain anonymous, fearing career reprisals, but the allegations are serious: watered-down findings, retracted studies, indefinite delays in receiving agency approvals to publish controversial papers. Four of those scientists were working on issues related to pollinator declines, says Jeff Ruch, PEER's executive director.

Chavonda Jacobs-Young, USDA-Agricultural Research Service administrator, denies any such problem, saying that "scientific integrity and rigorous science are of the utmost importance to us."

The USDA inspector general, however, announced in early 2016 that she'd received a "significant volume" of scientific censorship complaints, enough to trigger an investigation.

Pettis himself may have been a victim. In summer 2014, he was demoted, just two months after he testified before Congress. "I was asked by the [ag] committee to restrict my testimony to the Varroa mite," says Pettis. But under questioning, he declared that neonics raise the danger for bees to "a new level."

While no one at the USDA ever mentioned his testimony as the main reason for his demotion, Pettis says, he heard rumblings that he had angered people downtown.

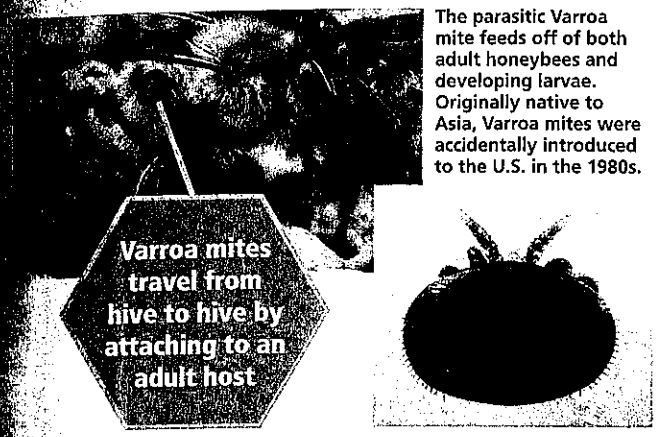
The controversy over bee declines has driven Pettis and vanEngelsdorp — Batman and Robin, once poised to save the bees — to separate scientific corners.

Pettis even retired early from his post at USDA-ARS, in large part because he says he felt "muzzled" by government policies that prohibit him from saying anything that might even be "construed" as reflecting on policy. "Chemicals," he says, "need to be used when indicated by signs or risk of pest infestation, as opposed to prophylactically."

I interviewed vanEngelsdorp, who sounded a different note in 2015, in his office at the University of Maryland, where he runs the Bee Informed Partnership, a consortium that includes government, industry and beekeeping constituents. He says the Varroa mites are a big problem, and typified pesticides as a lesser concern.

"As a scientist," vanEngelsdorp says, "I am motivated by the data."

He recently published a pair of papers that deepen the debate. In the first one, published online last April in *Apidologie*, he surveyed beekeepers and samples over five years from 41 states. He found that the Varroa mite is more prevalent than suspected, even when beekeepers follow good practices, and a significant vector for disease. And in a September study in *Nature Scientific Reports*, he found that exposure to multiple chemicals in a colony correlates with high rates of colony deaths. The evidence, gathered from 91 bee colonies owned by three commercial beekeepers, showed just trace amounts of neonics but did find that



The parasitic Varroa mite feeds off of both adult honeybees and developing larvae. Originally native to Asia, Varroa mites were accidentally introduced to the U.S. in the 1980s.

Bees born with deformed wing virus emerge with crumpled, misshapen wings and die within days. The virus is one of several closely associated with Varroa infestations.

fungicides are more prevalent than thought and closely correlate with bee deaths. The finding seemed to slightly push vanEngelsdorp, who commented in a news release at the time that we need to "make sure we only use the products we need, when we need them."

Former commercial beekeeper David Mendes, who serves with vanEngelsdorp on the Bee Informed Stakeholder Advisory Board, praises his ethics and rigor but says the politics are important. "I think Dennis would need the evidence to be beyond incontrovertible before he could take any stand on pesticides," says Mendes. "That's an even higher standard than science usually requires."

Darren Cox's personal enlightenment about the ways in which science can be subverted reached full bloom when the USDA mounted a series of workshops on the stressors affecting bee health. The agency invited him to two meetings covering mites, viruses and bee nutrition. Agency representatives assured him for months, he says, that a pesticides roundtable would follow. Then, he says, "They told us, 'There isn't going to be any meeting on pesticides.'"

Cox readily acknowledges that his bees are "afflicted by a variety of stressors." But talking about this decision, his frustration shows. "The USDA's own website, on the science of bee health, lists four stressors, including pesticides," he says. "But that's the one thing they wouldn't hold a meeting about. Now, why is that?"

"THE HONEY HUM"

On the last day of my trip to Utah, at a peak time of day for bee foraging, Cox took me to a bee yard wedged tightly between a farm and a major road. Arrayed before us were at least three prime bee-attractors: milkweed, safflower and thistle, in full bloom.

I expected Cox to open the top box on one of the "bee stacks," to check on their health. But instead he walked right through the bee yard to the surrounding field.

"You hear that?" he asked.

"Hear what?" I responded.

"Exactly," he said. "The sky should be filled with bees, and you should hear them. We call it 'the honey hum.'"

The sky was empty, and the only noise was the sound of the wind.

His bees, many tens of thousands of them, crawled and hovered listlessly around their hives. Neonics are not so prevalent by Cox's bee yards, but other chemicals are, including Lorsban, which attacks the nervous system. Further, as a commercial pollinator, Cox comes into contact with all the chemicals, including neonics, used in the areas he visits, and those chemicals can wind up in his bees.

Immediately after witnessing this dismal scene, Cox took me to a bee yard where he keeps another trove of bees, up in the mountains, away from any development or farms. There, the sound was unmistakable — a warm buzz.

The prospect of weaker bees, which fail to forage even in abundant habitat, is not a product of beekeepers' imaginations. Scientists like Pettis, Lundgren and vanEngelsdorp seem to agree on this: Bees are less vigorous than before.

Of course, they are also dying.

Over the winter, 2015-2016, fellow beekeepers called Cox and reported record losses. Hackenberg lost 90 percent of his stock, saying they "disappeared" just like they did during colony collapse. Cox is suffering, too. He recently had to make up the loss of 30 percent of his hives.

The bad year, however, might actually turn out to be a good thing.

The price per hive for crop pollination continues to increase. Soon the plight of the honeybee might force such massive cost increases that angry citizens will demand change. In April 2016, a group of Bayer shareholders publicly demanded that corporation executives "turn away" from neonics because they are linked to bee declines. In addition, Cox and his fellow beekeepers have become increasingly political, writing letters of protest about Pettis' demotion, contributing significant funding to a new, private lab for Lundgren — the whistleblower who has now left the USDA — and looking for ways to provoke action.

Toward the end of a day spent checking on his suffering bees, Cox pointed his truck up a steep mountainside in the Cache Valley and expressed his newfound sense of place in this scientific debate. "Whatever feeling we once had — that this was all going to go smoothly or in some typical, orderly process, and science was just going to figure this out and we'd get back to business — is long gone," he says. "This is a fight." D

Steve Volk is a contributing editor at Discover.