

# Man v rat: could the long war soon be c

Rats spread disease, decimate crops and very occasionally eat people alive. For centuries, we have struggled to find an effective way of controlling their numbers. Until now ...

by

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**F**irst, the myths. There are no “super rats”. Apart from a specific subtropical breed, they do not get much bigger than 20 inches long, including the tail. They are not blind, nor are they afraid of cats. They do not carry rabies. They do not, as was reported in 1969 regarding an island in Indonesia, fall from the sky. Their communities are not led by elusive, giant “king rats”. Rat skeletons cannot liquefy and reconstitute at will. (For some otherwise rational people, this is a genuine concern.) They are not indestructible, and there are not as many of them as we think. The one-rat-per-human in New York City estimate is pure fiction. Consider this the good news.

In most other respects, “the rat problem”, as it has come to be known, is a perfect nightmare. Wherever humans go, rats follow, forming shadow cities under our metropolises and hollows beneath our farmlands. They thrive in our squalor, making homes of our sewers, abandoned alleys, and neglected parks. They poison food, bite babies, undermine buildings, spread disease, decimate crop yields, and *very* occasionally eat people alive. A male and female left to their own devices for one year – the average lifespan of a city rat – can beget 15,000 descendants.

There may be no “king rat”, but there are “rat kings”, groups of up to 30 rats whose tails have knotted together to form one giant, swirling mass. Rats may be unable to liquefy their bones to slide under doors, but they don’t need to: their skeletons are so flexible that they can squeeze their way through any hole or crack wider than half an inch. They are cannibals, and they sometimes laugh (sort of) – especially when tickled. They can appear en masse, as if from nowhere, moving as fast as seven feet per second. They do not carry rabies, but a 2014 study from Columbia University found that the average New York City subway rat carried 18 viruses previously unknown to science, along with dozens of familiar, dangerous pathogens, such as *C difficile* and hepatitis C. As recently as 1994 there was a major recurrence of bubonic plague in India, an unpleasant flashback to the 14th century, when that rat-borne illness killed 25 million people in five years. Collectively, rats are responsible for more human death than any other mammal on earth.

Humans have a peculiar talent for exterminating other species. In the case of rats, we have been pursuing their total demise for centuries. We have invented elaborate, gruesome traps. We have trained dogs, ferrets, and cats to kill them. We have invented ultrasonic machines to drive them away with high-pitched noise. (Those machines, still popular, do not work.) We have poisoned

them in their millions. In 1930, faced with a rat infestation on Rikers Island, New York City officials flushed the area with mustard gas. In the late 1940s, scientists developed anticoagulants to treat thrombosis in humans, and some years later supertoxic versions of the drugs were developed in order to kill rats by making them bleed to death from the inside after a single dose. Cityscapes and farmlands were drenched with thousands of tons of these chemicals. During the 1970s, we used DDT. These days, rat poison is not just sown in the earth by the truckload, it is rained from helicopters that track the rats with radar - in 2011 80 metric tonnes of poison-laced bait were dumped on to Henderson Island, home to one of the last untouched coral reefs in the South Pacific. In 2010, Chicago officials went “natural”: figuring a natural predator might track and kill rats, they released 60 coyotes wearing radio collars on to the city streets.

Still, here they are. According to Bobby Corrigan, the world’s leading expert on rodent control, many of the world’s great cities remain totally overcome. “In New York - we’re losing that war in a big way,” he told me. Combat metaphors have become a central feature of rat conversation among pest control professionals. In Robert Sullivan’s 2014 book *Rats*, he described humanity’s relationship with the species as an “unending and brutish war”, a battle we seem always, always to lose.

Why? How is it that we can send robots to Mars, build the internet, keep alive infants born so early that their skin isn’t even fully made - and yet remain unable to keep rats from threatening our food supplies, biting our babies, and appearing in our toilet bowls?

“Frankly, rodents are the most successful species,” Loretta Mayer told me recently. “After the next holocaust, rats and Twinkies will be the only things left.” Mayer is a biologist, and she contends that the rat problem is actually a human problem, a result of our foolish choices and failures of imagination. In 2007, she co-founded SenesTech, a biotech startup that offers the promise of an armistice in a conflict that has lasted thousands of years. The concept is simple: rat birth control

The rat’s primary survival skill, as a species, is its unnerving rate of reproduction. Female rats ovulate every four days, copulate dozens of times a day and remain fertile until they die. (Like humans, they have sex for pleasure as well as for procreation.) This is how you go from two to 15,000 in a single year. When poison or traps thin out a population, they mate faster until their numbers regenerate. Conversely, if you can keep them from mating, colonies collapse in weeks and do not rebound.

Solving the rat problem by putting them on the pill sounds ridiculous. Until recently no pharmaceutical product existed that could make rats infertile, and even if it had, there was still the question of how it could be administered. But if such a thing were to work, the impact could be historic. Rats would die off without the need for poison, radar or coyotes.

SenesTech, which is based in Flagstaff, Arizona, claims to have created a liquid that will do exactly that. In tests conducted in Indonesian rice fields, South Carolina pig farms, the suburbs of Boston and the New York City subway, the product, called ContraPest, caused a drop in rat populations of roughly 40% in 12 weeks. This autumn, for the first time, the company is making ContraPest available to commercial markets in the US and Europe. The team at SenesTech believes it could be the first meaningful advance in the fight against rats in a hundred years, and the first viable alternative to poison. Mayer was blunt about the implications: “This will *change the world*.”

Mayer is a tall, vigorous woman in her mid-60s with bright eyes, spiky grey hair and a toothy grin. Her ideologies of choice are Buddhism and the Girl Scouts. “It’s kind of my core,” she said of the latter, “to do for others.” In conversation, her manner is so upbeat that she seems to be holding forth radiantly before an audience or on the verge of bursting into song. When asked how she is doing, she frequently responds in a near-rapture: “If I was any better, I’d be a twin!” – she also appears to enjoy watching people wonder whether this is an expression they should know.

When I took a seat in her office earlier this year, she clapped her hands triumphantly and said “Ooh! You’re sitting in history and strength!” There was a pause. “I had a feng shui person come and do my office,” she explained.

Mayer came to science later than usual, in her mid-40s, after a career in real estate development and a stint as the international vice president of Soroptimist, a global volunteer organisation dedicated to improving the lives of women. The career change was unexpected, even to her. After a close friend died suddenly of a heart attack, Mayer called up a biologist she knew and asked how something like this could have happened. The biologist had no satisfying answer; she explained that while heart disease in men had been thoroughly studied, little attention had been devoted to post-menopausal heart disease in women. “Well you’ve got to change it,” Mayer replied, outraged. The biologist was otherwise occupied, so Mayer decided to do it herself. At 46, she entered a PhD programme in biology at Northern Arizona University.

After graduate school, her initial research as a professor of biology at Northern Arizona focused on artificially inducing menopause in lab mice so that she could study changes in the postmenopausal heart. Three years into her efforts, Mayer was contacted by Patricia Hoyer, a colleague in Phoenix, who said that she had stumbled across a chemical that seemed to make mice infertile, without having any other effects. Together, Mayer and Hoyer synthesised a new compound, which they called Mouseopause.

Shortly after Mayer and Hoyer published their work on Mouseopause in 2005, Mayer received a telephone call from a veterinarian in Gallup, New Mexico, who had read about her research. The Navajo reservation where he worked was overrun by wild dogs. There were too many to spay and neuter, so he was euthanising almost 500 a month. “If you could do for a dog what you can do for a mouse, I could stop killing dogs out here,” he told her.

Mayer describes herself as “extremely connected to animals, dogs in particular”. When she arrived in Gallup and saw the piled corpses, she agreed to test Mouseopause on an initial group of 18 reservation dogs. “I held up that first puppy, who I called Patient Zero,” she told me, “and I said, ‘I don’t know what this is gonna do to you, but you will live on a satin pillow the rest of your days.’” The injection made the dogs infertile, but left them otherwise happy and healthy. (Mayer brought home all 18 dogs and built a kennel in her yard to house them until she could find homes for them with families she knew personally. Patient Zero, renamed Cheetah, lived with her until she died of old age – though the pillow was fleece.)

The next call came from Australia in 2006. Biologists there wanted an adaptation of Mouseopause for rats. Rats, they told her, were eating 30% of the rice crop in Australia and Indonesia. If she could reduce the rat population by even half, they claimed, the crops that would be saved could feed millions of people.

Mayer was moved by the idea of finding a solution to rat overpopulation that was neither lethal nor toxic. Since its invention, rat poison has been our primary method of curbing rat populations, but it is dangerous. Ingested in high doses, it's fatal to humans, and it poses a particular danger to children because it is sweet and brightly coloured. In the US alone, more than 12,000 children per year, most of whom live below the poverty line, are accidentally poisoned by pesticide meant for rats.

The collateral damage inflicted by rat poison also extends to the environment, leaching into the soil and poisoning house pets, farm animals, and wildlife that feed on rats. Worst of all, rat poison is not very effective at eliminating large infestations. As long as there is still a food source, colonies bounce back, and, especially in Europe, rats have grown resistant to the toxins. As Mayer often says, "Doing the same thing over and over and expecting different results: isn't that the definition of insanity?"

Persuaded by the research, and by her wife, fellow biologist Cheryl Dyer, Mayer decided to devote her career to developing a new, smarter way to control the rat population. In 2007, they founded SenesTech. "People say never to invest with a husband and wife team," Mayer joked to me. "I say, 'Oh absolutely not! Then you have dominance.' But wife and wife? Works great!"

For Dyer and Mayer, the immediate problem was obvious: while the lab mice and feral dogs had received injections in controlled studies, wild rats would have to eat the formula of their own volition. Rats are neophobic - they avoid what they don't know. What's more, city rats are already well fed. In New York City, for example, they have fresh bagels, pizza, melted ice cream and fried chicken in unending supply. To succeed, Dyer and Mayer had to make the compound not just edible but delicious.

After a series of tests, they quickly settled on a liquid, rather than solid, formulation. Rats have to drink 10% of their body weight every day to survive, and so are always looking out for something potable. "We compared the [two] and they peed on the solid and drank the liquid," Dyer told me. "Rats are pretty straightforward."

Where Mayer is tall and voluble, Dyer is short and broad-shouldered, quiet and succinct. She seems most comfortable behind the scenes, if only because it is easier to get away with wearing Hawaiian-print shirts and no shoes. At SenesTech's headquarters, Dyer's windowless office is right next to Mayer's, and if Mayer's office evokes Zen, Dyer's evokes an island paradise. Scenes from Hawaii cover her walls, hula (and rat) figurines line the shelves, and on her desk sits a small wooden sign, which says, "WELCOME TO THE TIKI BAR." There is also a widescreen TV, on which Dyer likes to watch old movies on mute all day.

It was Dyer's job to make Mouseopause palatable for rats - a tricky proposition because its active ingredient, 4-vinylcyclohexene diepoxide (VCD), is bitter and caustic. Rats have the same taste preferences as humans - they love fat and sugar - though Dyer's experiments with various flavour profiles indicated that their appetite for both exceeds ours.

She was also tasked with the greater challenge of adapting Mouseopause to work on rats, which are much harder than mice. While VCD caused the eggs in mouse ovaries to degenerate rapidly, female rats were far less susceptible. Hoping for a compound effect, Dyer added a second active ingredient: triptolide, which stunted any growing eggs. The results were better, but still not good enough. "They just had smaller litters, goddammit," she said.

Eventually, out of a mix of curiosity and desperation, she fed it to both males and females. The result was dramatic. It turns out that the triptolide destroyed sperm - the males became sterile almost immediately after ingesting the formula. This was a total surprise: no one had ever tested triptolide on male rats before. It was “stunning”, Dyer told me. “Totally unpredictable.” Test after test: no pups. She sighed. “Man, you should have seen the No Pup party.” After three years of research and development, they had a product that worked and did not harm other animals. (The active ingredients are metabolised by the rat’s body in 10 minutes, which means that any predator that eats it is not affected, and the compound quickly breaks down into inactive ingredients when it hits soil or water.)

ContraPest, the finished product, is viscous and sweet. Electric pink and opaque, it tastes like nine packets of saccharine blended into two tablespoons of kitchen oil. “Rats love it,” Dyer said. “Love it.” Mayer, who taste-tested every version during the development process, could not say the same for herself.

In 2013, New York’s Metropolitan Transit Authority (MTA) reached out to Mayer after hearing about SenesTech’s early trials to ask whether the company would test ContraPest in New York’s subways as part of a citywide effort to find new, more successful alternatives to poison. Many cities devote manpower and money to keeping the rats under control, but New York, which is more or less the rat capital of the western world, is the epicentre of anti-rat efforts. Every incoming mayor of New York declares his intentions for a vast rodenticide - Giuliani even appointed a “rat czar” to oversee the carnage - only to leave the next guy even more to deal with.

When the MTA officials contacted Mayer, she recalled, they were worried that the formula would not work on New York rats, which have the reputation of being bigger, tougher, and smarter than any other city rat in the world. (Norway rats, the species infesting New York, are not in fact the largest rat type.) They asked Mayer whether they should send a few New York rats on a plane to Arizona so that SenesTech could experiment with them before coming to New York. “No, I don’t think so,” replied Mayer, amused. “I never met a rat I couldn’t sterilise.”

Mayer dispatched two of SenesTech’s youngest scientists, women in their 20s, to New York in order to test whether the formula was appealing enough. Would New York rats prefer ContraPest to water or pizza? Wearing their best approximation of hazmat suits to protect themselves from the filth, the scientists patrolled the subway’s trash storage rooms under Grand Central Station. They planted bait boxes filled with feed stations of ContraPest and then stood nearby, counting the rats that came in and out with clickers in order to track how many rats were taking the bait. For six months, they baited and counted, washing their suits at the end of each day in bleach.

The two young women went home to Arizona with good news: not only did the New York rats drink ContraPest, the drink actually worked on them. The test confirmed the highest hopes of the company - there was an alternative to poison that would work, even in New York City, and they had found it.

**W**hen humans and animals come together, there are choices. Mayer believes that if you understand the ecology of the animal and you understand your own ecology, then you and the animal will be able to coexist peacefully. After centuries of misperception and squeamishness, we finally have a good grasp of rat ecology. Now the problem may be our reluctance to look too carefully at ourselves.

In his 1983 book *More Cunning than Man*, writer Robert Hendrickson lists “the obvious ways in which rats so well resemble humans: ferocity, omnivorousness, adaptability to all climes, migration from east to west in the life journey of their species, irresponsible fecundity in all seasons, with a seeming need to make genocidal war on their own kind.” He describes rats and men alike as “utterly destructive, both taking all other living things for their purposes.”

Humanity’s long struggle with rats mostly signals the worst traits we share with them: our inability to live responsibly within our environment; our tendencies toward hedonism and greed; and our failures to look after the weakest among us. Getting rid of them means correcting ourselves first.

SenesTech is not alone in its attempts to devise a more sustainable, responsible method of ending the rat problem. Its work is heir to an existing method: integrated pest management, or IPM, which holds that if humans – particularly city-dwellers – took more care with their environment, rats wouldn’t thrive.

IPM’s most vocal advocate is Bobby Corrigan, who has brought its principles to farmlands and cities all over the world, most notably New York, which recently revised its rat control programme on his advice. Twice a year, he teaches the New York health department’s “Rat Academy”, a three-day training for industry professionals. This April, there were maybe 100 attendees wedged into wooden theatre seats in a downtown auditorium, holding weak coffee and spongy muffins.

Corrigan is a thinnish, pale man, bald except for a low, wispy crown framing his ears. He spends his nights on the streets or in basement corners studying rats. Once, he lay in an alley with peanut butter spread around him all night so he could get good photographs. (“No, it wasn’t safe. Yes, they were urinating on me. In grad school, you do crazy things.”) He regards his work with utmost seriousness.

“Here’s what health professionals do,” he said to his audience by way of introduction. He pointed at a slide behind him and read aloud.

*We protect the roof over people’s heads.*

*We protect the food they eat.*

*We protect their health, comfort and safety.*

“I’m not saying this to pat us on the back. This is real. This is our job. [Rats] get on airplanes. They gnaw on wires. They cause diseases. To me, this is the shot heard round the world.” Then he spent 20 minutes explaining how to divine information from rat droppings based on their moisture.

As the day wore on, Corrigan’s core message for his audience emerged: fighting rats means committing to holistic efforts, not looking for a quick, flashy fix. “We love to spritz problems away,” Corrigan told me later. “A chemical or a trap, it’s a Band Aid, and they’re Band Aids that come off very quickly.” Instead, Corrigan argues that you first need to remove the rat’s food, then remove the rat’s shelter, and only then take lethal measures if you have to.

In theory, this solution is simple. It does not involve radar or guns. Instead, it demands lids for the trash can, and caulking for the cracks in foundations, or “keeping our own little nests clean”, as Corrigan says. It is the obvious answer, the one that has been sitting under our noses for centuries: stop feeding them, stop housing them, and they will go away on their own.

The problem is that people, as a rule, prefer the quick fix. Setting out poison is easier; the ultrasonic machine looks cool. The sensible, labour-intensive option meets with resistance. Often, when Corrigan is called out to consult with a property owner, the owner rejects his advice, simply because following it would require too much thought, effort or expense.

And sometimes, even those who are willing to try his methods do not have the resources. Ricky Simeone, the director of pest control for New York's health department, explained to me that the neighbourhoods that struggle with the worst rat infestations are not the ones who file the most reports to his office. The poorest neighbourhoods are too overwhelmed with other social or economic problems to file complaints - or, worse, they accept rat infestation as one of the conditions of living in poverty.

Corrigan confirmed that rats, especially in cities, affect the poor more than the rich, because effective pest control services are expensive. But he pointed out that no one totally escapes the rat problem, no matter how rich. Cities such as New York make evident a universal truth. "We're all holding hands whether we know it or like it. Your rats are my rats. If the city blows it off, the sewer rats become everybody's rats. Rats are everybody's issue."

"Everyone thinks, 'It's not my job, it's someone else's job,'" Corrigan continued. "They think, 'Oh I live in New York, no one can get rid of the rats in New York!'" He gave a short sigh. "We don't think we can do it alone, so we don't do anything as a group." As with all conditions that threaten everyone but torment the disadvantaged above all, the situation is not better because we are not better.

"Homo sapiens," Corrigan said to his audience at the Rat Academy. "Does anyone know what this means?"

He smiled a grim little smile. "Wise man."

Improving society is a collective project, but as Corrigan attests, it happens because individual people make it their business to incite change. Mayer and Dyer, too, see this as their mission. "We have to be better stewards than this," Dyer told me fiercely. "We're better than this." If SenesTech looks quirky in the attempt, its founders do not seem to mind.

**O**n a Tuesday night in August, Mayer and Dyer held a celebration in their backyard for staff and investors. The company had just received US Environmental Protection Agency registration, a process that usually takes years and often costs more than companies of SenesTech's size can afford. (The EPA is making an active effort to get rat poison off the markets in the US, and received news of SenesTech's science with enthusiasm.) Now, with the EPA's blessing, the company could take ContraPest to commercial markets. Immediately, more than 100 calls and 200 emails came in with order requests.

Mayer and Dyer live in a one-level wood cabin a few miles north of downtown Flagstaff, in a wooded area near a field of wildflowers. For the occasion, they had cleared the back patio, where Mayer does her morning meditation and yoga, and filled it with deck furniture and folding tables. The sun was coming down the San Francisco Peaks.

It was not a typical investors dinner, but then, SenesTech's nearly 700 stakeholders are mostly firemen. While most biotech startups are funded by investment bankers and venture capitalists,

Mayer chose to pursue funding from grant-giving bodies and a horde of private donors, all of whom made small investments, and each of whom Mayer knows by name. It was a pure accident of networking that so many of them turned out to be firemen, but she is thrilled with the situation. “Firefighters really believe in doing good,” Mayer explained to me. “And they’re like teenage girls. Once one of them invested, they all wanted in.”

There were perhaps 25 people - investors, board members and SenesTech staff - gathered on the back patio, eating tacos and drinking from Mayer and Dyer’s impressive liquor collection, but they made noise for 50. They were boisterous and loving, hugging each other, teasing each other, shouting old stories to roars of laughter, and clinking glasses. About half the room seemed to be wearing Hawaiian patterned shirts.

When the time came for Mayer to give a speech, she demurred for a moment before standing. Her toast turned briefly into an anecdote about flattening mouse skeletons in lasagna tins. “But seriously,” she said, returning to her theme, “We knew [this day] would come. It’s great to be riding this wave with you. It’s just so sweet.” Glasses heaved into the air.

There was considerable work left to do: now that SenesTech had its national registration, it would have to file for registration in every state. (Since then, the company has registered in 11 US states, and begun registration in the EU.) The manufacturing team was hurrying to make enough ContraPest to accommodate the requests coming in. Dyer was working hard on adaptations that would make the formula work in a variety of different environments, and planning variations for different species. Mayer was preparing for a torrent of meetings. While ContraPest has been effective in every test SenesTech has run so far, there is a lot still to learn about how rats in different parts of the world will respond to it in the wild.

It sounds crazy: a band of animal lovers and firemen in the mountains of Arizona, led by a Buddhist girl scout, making a pink milkshake for rats that may eventually improve the lives of millions of people. They are unruffled by scepticism: In the middle of one interview, Mayer forgot a detail and yelled towards the door, “Cheryl, who said to you, ‘That’s just not how we do it?’” Dyer hollered back from the other room. “Which time?” In response, they point to hard science, solicitations from governments and companies around the world, and an endorsement from Stephen Hawking, who featured them on his documentary mini-series *Brave New World*.

Rats are so longstanding a threat to humanity that contemplating an end to the rat problem - and one that does not require us to kill them - seems like a fantasy. They are, as Mayer herself put it, a more successful species than us. Long after we’re gone, they will still be here. But the possibility of a truce seems closer than ever before. “The answer in the future may lie completely within biotechnology,” said Corrigan when I asked for his impressions. (He and Mayer consider themselves allies in the campaign to create sustainable solutions to the rat problem. Mayer fondly recalls a nighttime “rat safari” she once took with Corrigan in New York.) “The SenesTech product is a breakthrough, but it is still at the very infancy stages of biotechnology for this species,” Corrigan said. “This is going to be maybe years of refinements and changing and experiments. We’re not walking yet. And we’re certainly not running.”

Mayer, Dyer and their team seem cheerful at the prospect, and confident that they are doing the work of the future. “Do you see this?” asked Ali Applin, a senior member of SenesTech’s staff. We were sitting in Mayer’s office, and Applin pointed to a little sign on the coffee table that read “Make it so.”



“This is what she tells us,” Applin said.

Mayer nodded, smiling. “That’s what you need to do. I mean, why squabble over something and say, ‘I can’t do that’. Make it so. Find a way. There’s always a way.”

After a moment, she had another thought. “You’re really gonna have to do that, Ali, when you take this to Argentina soon. If we thought Laos was hard – I mean, my God.” She grinned mischievously and folded her hands together and pressed them to her forehead and said a mantra. “I wish you ease on the path to peace. I wish you an end to your suffering.”

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. This article was amended on 20 September 2016. An earlier version incorrectly stated that DDT is the active ingredient in Agent Orange, and suggested that *C difficile* is a virus.

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