Our Fight for BEES

Creating a new global generation of beekeeping.

By Laura Marjorie Miller

Photos by John Solem • Bee Photo by Sam Droege

NE HUNDRED YEARS AGO, when UMass Amherst was Mass Aggie, Butterfield was a field, and Orchard Hill an orchard, 50 beehives hummed behind an apiary laboratory on the eastern edge of campus.

Massachusetts Agricultural College was a hub of beekeeping education, the first college to offer a formal beekeeping program. There was a full-time beekeeping professor until 1969, when **Frank Shaw '31**, the last to hold the post, retired. Extension faculty members like **Richard (Dick) Bonney '54**, the author of beekeeping books that are still bibles in the trade, passed their knowledge on to students.

Yet the program slowly went dormant over the years, as the academic focus shifted away from insect husbandry.

One hundred years later, there is a resurgence—the steady, perceptible buzz of an institution reactivating its legacy, this time to solve and remediate a pressing mystery: the loss of honeybee hives all over the planet.

But this time, the beekeeping is happening globally. Through its researchers, staff, and students, the historical authority of Mass Aggie has expanded to a new way of keeping bees: an ecological perspective that aims to preserve not just honeybees, but *all* bees, both domestic and wild.

Habitat that
flowering plants
love is habitat
that bees love.

A Catastrophic Collapse

IN THE mid-2000s, beekeepers began to notice a curious, dismaying occurrence: entire hives going missing, either vanished or dead. Between 2006 and 2007, beekeepers lost 30 to 40 percent of their hives. Every year since, they have lost approximately the same proportion, in a phenomenon that has come to be called Colony Collapse Disorder (CCD). And obviously, since so much of our agriculture depends on the activity of pollinators, if this collapse continues or escalates, it threatens disastrous consequences for our civilization's food supply.

If you follow news regularly on social media, you know that an alleged smoking gun for the bee crisis will be found on a fairly regular rotation, whether that cause is varroa mites, neonicotinoid pesticides, or even electromagnetism from mobile phones.

Yet every researcher interviewed for this article describes the bee crisis as *multifactorial*. Where a resilient, healthy pollinator population might be able to resist any one of these factors, together they create a constellation of afflictions. Pathogens. Parasites. Miticides that weaken bees' nervous systems and immune systems. Loss of habitat, due to industrialized agricultural practices and development, which limits bees' resources to nest, forage, and self-medicate. Beekeepers who feed bees exclusively with sugar water so that they become malnourished. Fewer feral honeybees to enter the mix, and reliance on a limited array of bloodlines from commercial queen breeders. All of these factors have narrowed the genetic spectrum for the honeybee population, making it less diverse.

With agriculture increasingly dependent on migratory beekeepers who canvass the country bearing honeybee hives on the backs of their trucks, the combination of factors together creates an ecological high-wire act with a perilous balance and a costly free fall. Any one factor could prove a tipping point.

Yet the invisible safety net might be native bees, nearly 400 species of which live in Massachusetts alone. And the solution to the bee crisis may be to stretch that net wider than we ever have before.

A Pernicious Parasite

HONEYBEES HAVE lived for thousands of years in a mutually beneficial relationship with humans. They are familiar and charismatic. In many ways, that charisma now makes them ambassadors for their wild cousins, bellwethers for what is occurring to the natural as well as the cultivated landscape.

"CCD is specific for honeybees, but these issues cause problems for other bee species, including solitary bees," says John Burand, an insect pathologist in the Department of Microbiology. "Basically, what's good for the honeybee is good for the native bees; what's bad for the honeybee is bad for native bees." So could bolstering wild bees also benefit the honeybee?

Burand surveys levels of pathogens in honeybee populations, specifically studying the microbes, viruses, and parasites that cause disease in bees, and how they move across species lines. Even though his focus is on honeybees—he keeps several research hives in secret rooftop locations on campus—Burand wants to expand the discussion to native and feral pollinators, who are also threatened, and away from discussing just CCD: "Bee *health* is the issue."

As a microbiologist, Burand has chosen to focus on one particular factor of bee health: the aptly named *Varroa destructor*, a pernicious parasite that is the bane of beekeepers, and has also wiped out most feral honeybee populations. "You know the image that you grew up with of Pooh Bear finding a beehive full of honey in a honey tree? That doesn't exist anymore." The reason is varroa mites.

Without feral bee populations to diversify genetics, honeybees—which are not native to North America—start to suffer all of the problems of breeding only from a narrowing band of genetic strains, one of which is decreased resistance.

Fewer mites would mean more feral bees, which would mean stronger strains of domestic bees, which would mean increased ability to resist mites. The key is intercepting the old cycle and initiating a new one. Burand's dream is to create a biologically based method "to put the varroa mite on the endangered species list."

Life As We Know It

HAVING FEWER bees threatens not only our food supply, but also biodiversity. Bees have influence far beyond human agriculture, points out **Joan Milam '97G**, a bee taxonomist and adjunct researcher in the Department of Environmental Conservation. "Native bees are supporting the ecosystem as we know it," she says.

"There's drama in this garden," Milam enthuses, walking through the Franklin Permaculture Garden. And she is right: in the company of a melittologist, you suddenly tune in to how busy everything is at the insect level, with many individuals going about their work of the day, and bee predators like conopid flies lurking to pounce from the petals and lay their eggs in bumblebees.

Bees and flowering plants co-evolved during the Cretaceous period, explains Milam. As bees diverged from wasps, developing special traits such as branched hairs to maximize their pollen-gathering potential, flowering plants were also evolving to tempt bees—figuring out that those that attract the most bees have an evolutionary advantage. While some plants can self-pollinate, this obviously limits their genetic diversity. Relying on happenstance factors such as wind dispersal, water dispersal, or incidental pollination by a passing animal is unpredictable and unreliable. But if you can enlist bees to do your pollination, you can spread your genes quite widely. So flowers began to compete for the attention of bees.

Since they co-evolved, the habitat that flowering plants love is also a habitat that bees love. Milam recently completed a three-year study in the unique environment of the Montague Sand Plains, a glacial outwash with sandy soil ideal for bees that nest in the ground. Milam measured how bee density and diversity responded to this exceptional opening in otherwise thickly forested western Massachusetts. In that study, from that site alone, she collected 158 species of bee—almost half of the total species found in Massachusetts, including a species that

Olivia Biller, project manager for the Adler Lab, observes bumblebees on a cluster of flowers at the UMass South Deerfield farm: "You need three hands—for your clipboard, your pencil, and your timer."

was new to science.

Apparently, bees thrive in successional habitats, such as sand plains, but also those created by storm microbursts and fires—even what we might consider marginal and scrappy areas like abandoned gravel pits. "Openings in timber benefit bees," says Milam. As Massachusetts has been reforested, trees have replaced much meadowland and other floral habitats favorable to bee nesting. "There's a saying," Milam smiles mischievously, "save a bee, kill a tree."

Rewilding Your Lawn

OUTSIDE HOLDSWORTH Hall, **Susannah Lerman '11PhD** leans over a patch of clover that has somehow evaded the mower. On a square meter that contains ten heads of clover, one can immediately count four big bumblebees steadfastly at work.

Lerman, a research professor in the Department of Environmental Conservation and ecologist with the U.S. Forest Service, studies urban wildlife. A large part of her work in reconnecting urbanites with native nature involves getting them to realize something so obvious that it's almost invisible: every person who owns or keeps a house has potential pollinator habitat as close as stepping out their front door. Once you see that, you can't *un*see it.

People tend to focus on large-scale agriculture when looking at pressure on pollinators, but lawns are habitat too, Lerman points out: "There are resources in your yard!"

With funding from the National Science Foundation, Lerman recently completed a study on how mowing regimes influence insect diversity. Working with ReGreen Springfield, she took advantage of the post-tornado landscape, getting citizens to volunteer their lawns to different mowing rotations: one week, two weeks, and three weeks.

The results were astonishing: in the 17 yards in the study, Lerman counted 112 species of bee, ranging from 20 to 50 species in each yard alone, including a bee that had not been re-

The UMass South Deerfield Farm is a site for Lynn Adler's research on the interaction between plants and bees.

corded in Massachusetts since the 1920s. And not only did she find bees, but also food for their forage: an average of 20 species of plants per lawn, with a total of 64 flowering plants in all the yards combined. "That's a lot of floral diversity!" she exclaims.

Lerman found that bee abundance peaks at two weeks, which seems to be the sweet spot between providing habitat and forage for bees and avoiding the hairy eyeball from one's neighbors.

The genius of Lerman's approach and appeal for busy people who want to benefit bees is that it entails *not* doing something: instead of planting elaborate pollinator gardens, basically just taking a week off between mows. And instead of seeing neighborhood associations as adversarial, Lerman encourages householders to see them as a "moment of opportunity" for education: shifting neighborhood aesthetics back to a more natural landscape full of clover to reflect sustainable values, and alternating mowing schedules with neighbors so that bees always have a yard in which to forage.

"Animals respond to the decisions people are making in surprising ways," says Lerman. "We aren't going to get rid of lawns, so the question is, how can we better manage them as a resource?"

Bee, Heal Thyself

BEHIND THE barns at the UMass South Deerfield Farm are rows of netting tents, each burgeoning with summer blooms—milkweed, snapdragons, foxglove, sunflowers—surrounding raised beds of canola. Eastern bumblebees—*Bombus impatiens*—hum hypnotically among the flowers. Alongside the plantings, students in tank tops and shorts kneel, tracking with Zen-like patience how long each bee spends on each individual flower.

Biologist Lynn Adler and her team are measuring how a common intestinal parasite, *Crithidia bombi*, affects how bees pollinate. "Parasites can affect how bees learn to handle new flower types," explains Adler. Afflicted bees can even lose the ability to interact with complex flowers when the parasite causes them to disconnect signals from rewards. Without the ability to interpret a flower, bees can't pollinate effectively.

Adler's research is multilevel, all having to do with the interaction among plants, pollinators, and parasites. Right now,

she and her students are comparing how complementary plantings—the flowers alongside the canola—transmit parasites, and then in turn how the parasites affect how much pollen the bees are able to collect. Determining which plants are less likely to transmit pathogens can help farmers decide what to plant alongside their crops.

And these hedgerows are also proving essential to bees' ability to heal themselves. Since, as we know, bees and flowering plants co-evolved, they are parts of the same working ecosystem. It stands to reason that there are other benefits within that system. So, given all the miraculous feats bees are capable of, would you believe that they can also be experts in herbal medicine?

Adler discovered that the nectar of certain flowers can be medicinal for bees, reducing their disease loads. Her findings, recently published in *Proceedings of the Royal Society B*, show that bees consuming these compounds have notably reduced infection. So if farmers plant hedgerow varieties that produce these natural herbal remedies, that is a natural treatment for their hives, and for native bees as well. Both preventative and remedial, complementary planting can reduce the need for chemical intervention—one factor, as we know, in colony collapse—while stoking a healthier, more resilient bee. Adler and her team are working hard to discover which plants work best.

Can a Farm Be an Ecosystem?

SINCE HUMAN agriculture is now entwined with the Earth's ecology, establishing long-term, sustainable bee health means implementing steps that benefit those entwined systems as a whole—an "agro-ecosystem," to use a concept key to the work of ecologist **Anne Averill '85PhD**.

Averill, professor of entomology in the Department of Environmental Conservation, is the lead researcher on a $3.3 million study on native bees. Averill concentrates her work at the UMass Cranberry Station in East Wareham. Part of her work involves studying the ways abandoned cranberry bogs can actually become good pollinator habitat.

The key, to Averill, is for food cultivators to explore bee-safe combinations, such as the ones Adler is testing: "Crops could get to a point to be a *good* place for bees," she emphasizes, " if they can come into harmony with natural systems."

So far, we have been doing it wrong. To accommodate the huge increase in demand for crops like almonds, farmers have been pushed to create massive uninterrupted monoculture tracts, which although they look abundant, are actually deserts to native pollinators, who need space to nest and rest. In a vicious circle, farmers then become 100 percent dependent on migratory bees trucked in from other places, bees that exchange pathogens as readily as sharing a sketchy public restroom at a concert venue.

Less reliance on migratory bees, then, keeps the whole ecosystem safer, and not only from pathogens. Supporting native bees creates a diversity of possible pollinators, and thus stability—if CCD does happen to migratory bees, a safety network of other pollinators is present and functioning at various sites all the time. By constructing bee-friendly environments, farmers would ensure not only that their produce has higher nutritional value and a greater yield, but also that a much thicker cushion exists between them and a potential pollination crash. New World crops, cranberries and blueberries in particular, are most effectively pollinated by the bees that co-evolved with them.

Of any ecosystem—or agro-ecosystem—Averill says, "You want it to be as vibrant as possible."

We Have a Remedy

THERE ARE many parts in play. Ecosystems and agro-ecosystems may seem so intricate that they're impossible to understand, but there are parts we do understand, and can act upon. To bolster bees, remove as many harmful factors as possible, and then introduce and foster beneficial factors, agricultural practices that give pollinators the resources they need to be healthy, both as nutrition and as self-medication. Foster habitat, even if just the edges of your land. There is power in the unassuming: in even a relatively small plot, landowners and nurseries can create a pollinator haven. Homeowners' associations can act together to make neighborhood standards more pollinator-friendly. And even if you don't own land, as much as your budget allows, you can vote with your resources, encouraging farmers away from control agents like neonicotinoids so that they will know that more harmonious methods are profitable.

On campus, the next generation of sustainable beekeepers is ascending. The Beekeeping Club, founded by **Eamon McCarthy-Earls '15** in 2012, is now an official Registered Student Organization, funded by student activity fees as well as the Stockbridge School of Agriculture and private donors. The Agricultural Learning Center, situated on Wysocki Field, affords students the opportunity to work with bees on the land. In the autumn semester, John Burand teaches seminars that follow the arc of a honey harvest, and as the culmination of their classes, his students get to take the honey they have helped cultivate home in time to share at Thanksgiving.

And all of the honey—100 percent of it—used by UMass Dining on campus comes from one local apiary: Warm Colors in South Deerfield, run by Dan and **Bonita Conlon '86G**. Warm Colors ships 300 pounds of honey to campus every other week. That's 50,000 pounds a season, an amount that is increasing as the chefs find more creative ways to use honey in their recipes. Using its significant buying power as a super-consumer, the campus is not only supporting local agriculture but also helping prevent the spread of pathogens among bee populations.

Just like social bees, humans can work together on many different levels to accomplish a goal that is entirely too vast to achieve alone—by doing something as simple as taking a break from mowing your yard.

"We're telling people that what they're doing is really important," says Lerman. "It will affect the natural environment, and you're part of it." UM

It Takes a Hive | *How you can help save the bees.*

Buy the ugly fruit.

"There has to be a change in the way consumers think about what they eat—they are promoting the use of pesticides."
—John Burand

Encouraging pollinators can be as much about not doing, as doing.

"Mowing every two weeks gives the greatest bee richness."
—Susannah Lerman '11PhD

Want to know the pollinator-friendly plants at the nursery? Let the bees show you.

"If you see bees on it, buy it, and stick it in your garden."
—Anne Averill '85PhD

Soak up the sun(flowers) and give bees a chance to self-medicate.

"Sunflower pollen **really** *helps them clear infection."*
—Lynn Adler

See the bounty in the everyday.

"Goldenrod is a really amazing pollen source at the edge of your yard."
—Eamon McCarthy-Earls '15