COLBY SEMPEK

Butterfly, 2008
Silver gelatin print, 24 x 16 in

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Reversing the Monarch Butterfly Collapse

Roundup Ready Milkweed

The strange-but-true story of the monarch and its long-distance migration lures and mystifies butterfly aficionados from grammar school children to wizened entomological specialists, myself included. I lived for years in Bodega Bay on the California coast. On the north side of our village, monarchs would cluster over winter in colonies clinging to the Australian eucalyptus and local Monterey cypress in Bodega Dunes park after flying in from points as distant as the Rocky Mountains. They kept me company while I was researching and writing my book *The Dangerous World of Butterflies.*

Other monarchs travel farther south. A couple of hundred miles down the coast from my bayside office, monarchs gather each fall at Natural Bridges State Beach near Santa Cruz, the only state monarch preserve in California. Nearby Pacific Grove, which calls itself Butterfly Town, USA, threatens fines of up to one thousand dollars for "molesting a butterfly in any way." It's been a crime since 1939 to harass any of the thousands of monarchs that overwinter in that Monterey Bay city.

Despite such support, in some places the monarchs are struggling. As I investigated the reasons for this, a thought began to take form: Could guerilla botanists take advantage of Monsanto's best-selling herbicide Roundup to help save the struggling monarch butterfly? Could hackers develop a Roundup-resistant milkweed and preserve the monarch larvae's sole habitat? Let me explain.

Although North American monarchs west of the Continental Divide are thriving, on the east side of the Rockies populations are suffering catastrophic collapse. Not only do those monarchs magically change from clown-colored caterpillars into majestic butterflies, they defy logic with a multigenerational, ultra-long-distance commute that transits Canada, the United States, and Mexico. The navigational details remain a mystery. No one knows for sure how the butterflies manage a journey from the northeast of North America to the few specific mountaintops in central Mexico where they breed.

Monarchs lay their eggs only on milkweed. The larvae those eggs eventually become feed on milkweed, filling up on a poison in the weed that makes them—once they metamorphose into butterflies—unpalatable for most potential predators. Monarch larvae *only* eat milkweed. No other food source supports the larvae. All indicators

suggest that if we kill off the milkweed, we kill off the black and orange wonders that flutter through our summers, those stained-glass signifiers of lightheartedness and rebirth. And we are killing off the milkweed.

Across America, milkweed is disappearing in direct proportion to the planting of massive amounts of acreage with genetically modified corn and soybeans. Farmers keep weeds out of their GMO corn and soybean fields with glyphosate. The corn and soybeans thrive because they are "Roundup Ready," laboratory created to tolerate the glyphosate herbicide Roundup. But the milkweed in the midst of the for-profit crops withers, turns brown, and dies.

Corn and soybeans often are planted fence line to fence line, leaving little opportunity for milkweed to find poison-free zones it can call home. In the couple of decades since GMOs and Roundup facilitated the switch from amber waves of grain and a variety of other crops to row after row of corn and soybeans, the monarch count, according to a joint venture of government and academic agencies, collapsed from over a billion overwintering in Mexico to just over thirty million.

When I visited the monarch homelands in Michoacán to research my butterfly book, I spent time with José Luis Alvarez Alcalá and Ed Rashin, two desperados who operate the nonprofit La Cruz Habitat Protection Project. Their goal is to reforest land around the monarch grounds—a national park that's now a UNESCO World Heritage Site—in an effort to discourage log poachers from stealing trees the monarchs call home. We rode in Ed's jalopy Ford Explorer into those mountains, through land scarred from slash-and-burn logging, heading up to check on the replacement saplings the two had planted. The old Explorer overheated, and Ed managed to get it stuck in the muddy, rutted excuse for a road.

That's when I witnessed a bizarre example of the at-times symbiotic relationships among the divergent players in the monarchs' midst. While we studied the stranded truck, a motley gang of poachers appeared, leading a couple of horses. Poles some thirty feet long that were healthy trees just hours earlier were hanging off the backs of the horses, about ten on each. Few words were exchanged. The poachers produced a rope, tied it to the front bumper, and pulled on it as Ed gave the cooled-off Explorer gas. The tires grabbed, and the truck was back on dry ground. The poachers unhooked their rope and headed off with their booty.

Destruction of monarch habitats in Mexico initiated the threat to the gorgeous butterfly. But the monarch's crisis no longer can be blamed solely on the illegal logging I witnessed in Michoacán. That's why when Mexican president Enrique Peña Nieto, Canadian prime minster Stephen Harper, and US president Barack Obama agreed last year to meet for one of their periodic summit conferences in Toluca, Mexico—close to the monarch breeding grounds—butterfly aficionados and preservationists hoped the trio would add monarch survival to the agenda.

A posse of artists and monarch scientists coauthored a letter to the three politicians urging milkweed remediation across North America. Conservationist authors Peter Matthiessen and Bill McKibben were among the signatories. "The monarch butterfly is literally being starved to death," they cried out in the letter. The group called for buffer zones between crops, zones planted with milkweed, along with further milkweed planting along roadsides. "We need a milkweed corridor stretching along the entire migratory route of the monarch," they wrote.

The plea in the letter signed by Matthiessen, McKibben, and the others failed to bring the presidents together to save that *milagro* their three countries share. Bland official word from the White House suggested butterflies were not on the Toluca meeting agenda. "At the Summit, the president looks forward to discussing with Mexican President Peña Nieto and Canadian Prime Minister Harper a range of issues important to the daily lives of all of North America's people," announced then spokesman Jay Carney, "including economic competitiveness, entrepreneurship, trade and investment, and citizen security."

The cool, nonspecific language was, as I noted in a Toronto *Globe and Mail* op-ed, a reminder that from the Keystone pipeline to drug trafficking to immigration, the three national leaders represent interests as divergent as those of the tree planters and the tree poachers I encountered in the mountains near Toluca. That said, the Obama administration on its own is conducting a creative experiment in an attempt to rebuild at least some contiguous butterfly habitat along a narrow strip of the monarch migration path, federally owned Interstate Highway 35. The freeway runs from Minnesota to Texas, and in 2015 the White House announced plans to make its right of way milkweed friendly.

From backyard butterfly gardens to long swaths of roadsides, every effort at conserving milkweed is good news. But it's not enough to counter the Roundup-caused devastation.

Who says Roundup is to blame for the dearth of milkweed and hence the monarch collapse? The list is long. The consumer advocacy group Center for Food Safety, for example, commissioned a 2015 scientific report that it says "makes it abundantly clear two decades of Roundup Ready crops have nearly eradicated milkweed in cropland of the monarch's vital Midwest breeding ground." University of Kansas insect ecologist Orley "Chip" Taylor is founder of Monarch Watch. He and his colleagues at the habitat conservation organization call the spread of Roundup Ready corn and soybean crops a leading cause for the precipitous drop in Midwest monarch numbers. Dr. Taylor cites Roundup as the milkweed killer and as causing unnecessary collateral damage. "Common milkweed had never been particularly abundant in crop fields," he wrote in an article for the National Resources Defense Council. "Other species were far more problematic for farmers. But Roundup didn't spare the plant just because butterflies liked it. As common milkweed died out, monarchs began to decline." The Xerces Society for Invertebrate Conservation correlated a variety of studies it considered credible and estimated a North American monarch population that's declined 90 percent since the early 1990s. That's not a typographical error: *ninety* percent.

Of course, correlation is not necessarily causation, and there is no empirical proof yet that the dramatic loss of monarchs can be blamed on the simultaneous eradication of milkweed. But even Monsanto shrugs that its poison may be to blame. The company's director of corporate affairs Tom Helscher told science journalist Warren Cornwall, who talked with Helscher when he was researching an article for *Slate*, that butterfly conservation needs to be balanced with "society's need to improve productivity in agriculture."

Monarch support organizations lament the loss of milkweed (and hence monarch) habitat. They work with farmers, training them to comingle milkweed with their crops. They preserve what land they can secure as succor for milkweed. They worry about so-called superweeds, weeds developing natural resistance to Roundup. The International Survey of Herbicide Resistant Weeds—an independent organization of scientists working in over eighty countries—counts thirty-two weeds that figured out on their own how to flourish despite being sprayed with Roundup. Unfortunately the monarch's milkweed is not one of them. As a result, in addition to covering their cropland with Roundup, more and more farmers find themselves again pulling weeds and tilling their land—exactly the type of labor-intensive and topsoil-destroying work that Monsanto promised would be history when it foisted Roundup on commercial agriculture and backyard gardens. And, according to a report from the Union of Concerned Scientists, "farmers are increasing their overall herbicide use" in an effort to control the superweeds. Monsanto's propaganda campaign for Roundup promised the opposite.

Small farms specialist Garry Stephenson at Oregon State University worries that the surge of glyphosate-resistant superweeds is encouraging the continuing and increased use of 2,4-D, an herbicide that's been available and used since post–World War II for the control of broadleaf weeds (so it kills the broadleaf milkweed). Dow AgroSciences wants to market GMO corn and soybeans that can tolerate 2,4-D so that herbicide can be used against superweeds. "It's an ancient herbicide," Dr. Stephenson told me. "It's volatile and unlike glyphosate the overspray blows beyond where it's sprayed." Some readers may recognize the name 2,4-D from the Vietnam War. It was half of the recipe used to formulate Agent Orange (2,4,5-T was the other component). US military forces sprayed twenty million gallons of Agent Orange during the war in the campaign to defoliate Vietnamese jungles. The resulting damage to the health of soldiers and civilians of both countries was devastating and continues. Monsanto and Dow Chemical manufactured Agent Orange for military use. Apologists for the use of 2,4-D on commercial crops insist that it was not the dangerous component of Agent Orange. Those advocates include John Entine, who writes for *Forbes*, as he puts it, "skeptically about science, public policy, media ideology and corporate responsibility," and serves as a Senior Fellow at the World Food Center's Institute for Food and Agricultural Literacy at the University of California,

Davis. Entine cites a report from the Oregon State University–based National Pesticide Information Center as proof 2,4-D is safe "in its proposed usages."

Maybe. But what happens when it is misused? That same report tells a chilling tale. "No occupational studies were found reporting signs or symptoms following exposure to 2,4-D under normal usage," it agrees, but then adds, "Symptoms of acute oral exposure to 2,4-D include vomiting, diarrhea, headache, confusion, aggressive or bizarre behavior. A peculiar odor is sometimes noted on the breath. Skeletal muscle injury and renal failure may also occur."

Reading that warning reminded me of an exclamation uttered in abject frustration by Dr. Lincoln Brower, a zoologist who has been studying the monarch longer than any other scientist: "It pisses me off." Dr. Brower and I were talking about the degradation of monarch habitat, and his voice rose with disgust and sadness as he lamented, "I think humanity is a disaster for this planet!"

Since monarchs seek milkweed only when they're looking for a spot to lay their eggs, and since milkweed is where the larvae develop—eating the milkweed as they transform first into caterpillars, then into pupae, and ultimately into butterflies—preserving an adequate supply of milkweed obviously must be a priority for saving monarchs.

So why not develop a Roundup-resistant milkweed? Inventing a Roundup Ready milkweed may seem counterintuitive, especially to those who oppose the massive use of herbicides on Big Agri crops. But what's the correct thing to do? Perhaps shut down Big Agri and its chemical dependency: massive herbicide spraying. Perhaps prohibit fence-line-to-fence-line farming and the resultant elimination of the indigenous plants such as milkweed that historically thrived between the crops and property lines of family farms. Perhaps stop the use of genetically modified organisms in food we eat and outlaw Roundup Ready corn and soybeans, as do many European countries, thereby reducing the use of the poison. These could be productive solutions—but in the current business and political climate, could that type of radical change really occur? And even if it eventually did, would it be in time to save enough milkweed to preserve the monarch?

But what if an army of Johnny Appleseed types—walking, driving, and flying across the American heartland, from Canada to Mexico—seeded Roundup Ready milkweed around (and on?) the Roundup Ready corn and soybean fields? This would not be an assault on the crops; corn and soybeans can coexist with milkweed. Could such a guerilla action propagate enough milkweed to provide monarchs with their needed food and habitat? Could such a grassroots action save the monarch and its magical migration—save this amazing butterfly, this glorious natural wonder, this treasured symbol and emblem of renewal and life?

I checked in with one of my favorite butterfly experts, University of California, Davis, entomologist Arthur Shapiro. He and I first met when I was researching my butterfly book, and he graciously took me on one of his butterfly-count treks along the banks of the Sacramento River. Back then he said about the fluttering insects that became his life's work, "They're tough little bastards."

When I proposed my Roundup Ready milkweed idea to Dr. Shapiro, he took a breath and, I was pleased to realize, considered it as a serious question. The scheme could work, he mused, "so long as the genetic change which rendered the milkweed Roundup Ready was not in any way inimical to monarch activity," and then he listed those activities: egg laying, growth, and development. "That would have to be tested empirically to be sure that the genetically modified milkweed was acceptable to monarchs."

Native-plant enthusiasts might well resist the arrival of GMO milkweed in their neighborhoods. Their responses, suggested Shapiro, likely would range from "it's sacrilegious and horrible to tamper with our native plants" to "it's wonderful to do this to enhance their survival under the technological onslaught." "One thing for sure," he said, "it would be highly controversial."

The Roundup Ready process was patented by Monsanto, but their first GMO soybean patent expired in 2014. Such patents make it illegal for farmers to save seed for replanting. Monsanto becomes their Roundup Ready pusherman; they must buy from Monsanto or risk prosecution. However, the company acknowledges the opportunities afforded when patents expire. "The transition of the first-generation Roundup Ready soybean technology into the public domain represents another benefit," crows its literature. "Patent expiration provides a means for public access to the technology. This system motivates individuals as well as companies to invest in all types of new technologies that make US farmers and our economy more competitive."

The availability of the technology combines neatly with a natural phenomenon, Arthur Shapiro told me. "Milkweed is extremely easy to propagate vegetatively. You would not need to wait for seed and the maturation of plants grown from seed. If you produce one plant, you could reproduce it infinitely." And that growth should not be of great concern to farmers since milkweed historically has not been much of a problem for soybean and corn crops.

One GMO milkweed plant is all that's needed for sea-to-shining-sea milkweed renewal. There are different types of milkweeds, some better monarch habitat than others. "You would probably need to work hand in hand with somebody who really knows his or her milkweeds to be sure you would have maximum effect."

"Could there be deleterious unintended consequences for the monarchs?" I asked Dr. Shapiro. "Might the GMO milkweed hurt the eggs or the larvae or the caterpillars or the butterflies?"

"I don't know of any," was his answer, "but you would need to establish that the plants were perfectly acceptable and suitable for monarch egg laying, growth, and development. The whole project would be wasted if monarchs can't use the milkweed."

Who might be motivated to take on this challenge, hunker down in a laboratory, and invest the time and energy needed to create Roundup Ready milkweed? Shapiro figures likely candidates are disgruntled Monsanto ex-employees.

For more than forty years, Arthur Shapiro has been recording butterfly populations from the San Francisco Bay to the east slope of the Sierra Nevada (where both milkweed and monarchs continue to thrive). He's studied butterflies worldwide, written heaps of essays and academic papers about them. "I do it because that's what I do," he told me when we first met. Encouragement from such an expert made me think my crazy idea might be worth pursuing. "It was a very good insight on your part," he offered, "a clever idea. It might even work," he said with growing enthusiasm. "I tip my nonexistent hat to you, sir," and from my experience with the good entomologist, I'm convinced such compliments don't come lightly from this scientist's lips.

As I was finishing this essay, I happened on a *New York Times* article from a few years back about the escalating milkweed and monarch crisis. Chip Taylor from Monarch Watch is quoted by reporter Andrew Pollack as offering what Pollack calls "a modest, possibly ironic proposal to biotechnology companies." Taylor said, according to the *Times*, "I would implore them to develop a Roundup-resistant milkweed." Not really, Dr. Taylor told me in a follow-up interview. "For years I've been joking about this, but I would never advocate it." Taylor worries Roundup-resistant milkweed just would result in farmers spreading different chemical poisons on their land.

Nonetheless, I am not alone! Roundup Ready milkweed could be an interim fix. First we need a team of biohackers who clone the gene that prevents glyphosate from performing its deadly deed (Monsanto found it for its patented corn and soybeans in bacteria growing near their Roundup factory). Then Team Milkweed mashes that gene into milkweed chromosomes. The result: Roundup Ready milkweed. Finally, the revolutionaries immediately must proclaim their handiwork an open-source invention so others can sow what they reaped. That will prevent Monsanto and its ilk from grabbing rights to GMO milkweed in order to keep it off the farms.

After our first successful GMO milkweed blooms, it's time to propagate Roundup Ready milkweed coast to coast and border to border—and keep our fingers crossed for the regal monarch.

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