

Monarch Rx: Butterflies obtain 'drugs' from withering plants

By Nancy Lawson

My meanderings down the garden path always reveal interesting sightings: the first violet bloom of the season, a tree frog hiding in the coral honeysuckle, a hickory horned devil caterpillar munching on hickory leaves.

But one evening in June 2019, something more mysterious stopped me in my tracks: a male monarch sinking his proboscis into the leaves of late boneset (*Eupatorium serotinum*). Despite of a proliferation of flowers nearby, the butterfly didn't seem interested in gathering nectar. Disturbed only by an occasional passing car, he briefly circled around some milkweed blooms but headed straight back to his original task. Zooming in with my camera, I could see that the monarch was also scratching a leaf with one of his feet, focusing on tiny holes made by flea beetles.

What could an adult butterfly possibly need from leaves? Why wasn't he fueling up on nectar from blooming flowers instead? My questions to the great hive mind of Facebook gleaned an important clue from a retired Smithsonian lepidopterist, Don Harvey, who sent me a 1983 paper titled, "Leaf-scratching—a specialized behavior of danaine butterflies (*Lepidoptera*) for gathering secondary plant substances."

I read with fascination as the paper's author, chemical ecologist Michael Boppré, described similar behavior among butterflies and plants in Kenya. As a professor at the University of Freiburg in Germany, Michael also studied the phenome-



Photo: Nancy Lawson

The author saw both a male and a female gathering PAs on a late boneset (*Eupatorium serotinum*) that was withering on top after the stem partly broke.

non in Central and South America.

Reading as much of his work as I could find, I learned that the behavior has a name—pharmacophagy, which refers to the gathering of plant compounds for reasons other than nutrition. Specifically, the monarchs and most other danaini butterflies—as well as some moths, grasshoppers, beetles and flies—collect pyrrolizidine alkaloids (PAs) from injured and dried plant parts for use in their defenses.

We can think of larval host plants like milkweeds as a kind of grocery store, Michael noted in his papers, while PA-containing plants serve as drugstores. PAs are concealed in intact plants and are detectable to insects only when cell walls start to break down. To access them from dry leaves, stems and roots, monarchs

apply a fluid that dissolves the PAs and then reimbibe it.

When my subsequent search for information about PA-pharmacophagy in the U.S. proved mostly fruitless, I eventually reached out to Michael for help, and to my delight, he sent an encouraging reply. Based on existing science, Michael already knew that monarchs in the U.S. were gathering PAs and wondered why more people weren't reporting it. Records were scant but included a sighting by a scientist in Florida in the 1970s and a more recent observation in Missouri, where a gardener found dozens of monarchs congregating on the roots of a dug-up pond plant in 2009. Researchers have also found pyrrolizidine alkaloids in the bodies of monarchs in California and Mexico.

PA-pharmacophagy is likely a common behavior in monarchs, so why haven't more people reported it? Even though the butterflies are not abundant in my central Maryland habitat, I've continued to see both male and female monarchs visiting withering and dried leaves of late boneset, sometimes for an hour or more at a time.

But if people don't look closely, they might assume the insects are just perching. Monarchs gathering PAs can also be hard to spot; last summer, I noticed that they often flew low in the meadow, several feet beneath the flowers, presumably because boneset leaves were withering from the ground up.

Plants use PAs in their own defenses against herbivores, and bonesets are far from the only ones that produce the compounds. By comparing species known to produce PAs with those that occur in the U.S., Michael posits that many plants in the *Echiteae*, *Senecioneae*, *Eupatorieae*, *Heliotropiaceae*, *Boraginaceae*, and *Crotalariaeae* families are potential sources of PAs for monarchs. That means that in my habitat alone, Joe-pye weed (*Eutrochium* spp.), Virginia stickseed (*Hackelia virginiana*), American burnweed (*Erechtites hieraciifolius*) and blue mistflower (*Conoclinium coelestinum*) might also produce the compounds.

After publishing a paper in *Ecological Entomology* and launching a community science project, Monarch Rx, we've received reports of monarchs gathering PAs from drying marbleseed (*Onosmodium molle*) in Iowa, dug-up Virginia bluebells (*Mertensia virginica*) in Michigan, dried Joe-pye in Florida, and cut blue mistflower in New York. The latter sighting came from Janet Allen, founder and president of the Wild Ones chapter Habitat Gardening in Central New York, after she intentionally placed the cut plants as baits on her patio table. Other gardeners and



Photo: Janet Allen

Monarchs gathered PAs from the roots of blue mistflower and Joe-pye weed in the garden of Janet Allen, president and cofounder of the Wild Ones Habitat Gardening in Central New York Chapter. PA-content within a given plant may vary and in some cases is highest in the roots. You can learn more about creating these "baits" at the Monarch Rx community science page.

scientists have reported observing monarchs probing withering leaves in the past, but they weren't sure what they were witnessing at the time.

Through Monarch Rx, we aim to gather as much community science data as possible to help answer some pressing questions. Which plants do the monarchs rely on? How many monarchs gathering PAs are male, and how many are female? Are they infected with *Ophryocystis elektroscirrha* (OE), the protozoan parasite that causes crumpled wings and can lead to early mortality?

In many related butterflies and moths, PAs not only boost defenses but also act as precursors for male courtship pheromones. But monarchs' courtship strategies are unique among danaini, involving more of a quick takedown by the male, so male monarchs aren't thought to need PAs for such purposes. Is it possible that the PAs are helping some monarchs bolster their offspring's defenses against OE infection? That's one of Michael's working hypotheses. Perhaps female monarchs who gather PAs—or possibly receive them during mating—pass the compounds along in eggshells. If so, monarch larvae who eat the eggshells might

be able to fend off OE sporozoites.

At this point, we have many more questions than answers. We invite everyone with an interest in monarch biology and conservation to keep your eyes open for this behavior, record as many details as possible, take photos and videos, and submit your observations to Monarch Rx. Though we don't yet know all the reasons for monarchs' PA-pharmacophagy, one thing is certain: Monarchs gather pyrrolizidine alkaloids from withering and dried plant parts, and they invest a significant amount of time and energy doing so. With your help, we hope to unravel the mysteries of this little-known, but likely important behavior in the world's most famous butterfly.

Find articles with more details and references by joining Monarch Rx at <https://citsci.org/projects/monarch-rx>.

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