Monarch Medicine

by Jaap de Roode

Monarchs are fascinating creatures. With their amazing metamorphosis from caterpillar to butterfly and their spectacular annual migration from North America to Mexico, you’d be hard pressed to find anyone who finds Monarchs boring.

Yet, amidst this natural splendor, I did not start studying Monarchs because they are beautiful or migrate. Or even because they are fascinating. Instead, I started studying them because they get sick. Ironically, it is through this interest in disease that we have uncovered a whole new side of Monarchs: it appears that Monarchs can be their own medical doctors.

Like humans, wild animals get sick, and Monarchs are no exception. In their natural habitats they are faced with a plethora of disease-causing agents, including viruses, bacteria and fungi. They also face horrible parasitoid flies that lay their maggots on the Monarch caterpillar; the maggots eat their way in and consume the Monarch from the inside out. Eventually they appear, as alien-like creatures, through the skin of the Monarch, leaving the dead caterpillar behind.

The parasite I am most fascinated with is slightly less gruesome, although it can be very detrimental to Monarchs. Ophryocystis elektroscirrha (try that one on the next spelling bee…) is a protozoan single-celled parasite that forms stumpy spores on the outside of the adult Monarch. When a female lays an egg on a milkweed plant, she’ll transfer some spores to her egg and to the milkweed on which the egg is laid. After hatching, her offspring caterpillar will eat the milkweed from which it hatched and unknowingly ingest the parasite spores along with it. The parasite spore will then break open in the Monarch’s midgut and release eight tiny parasites called sporozoites. These move into the caterpillar’s tissues and start replicating, producing huge numbers of parasites, eventually forming new spores on the emerging adult Monarch. A single ingested spore can give rise to no less than a million spores on the new butterfly!

This rampant growth of the parasite results in a whole range of disease symptoms to the Monarch. In the worst cases the parasite forms so many offspring that the Monarch’s tissues are so severely disrupted that it gets stuck to its chrysalis, and will never be able to fly, feed and mate. More fortunate Monarchs will manage to emerge from their chrysalis successfully, but will suffer in other ways — a lower ability to mate, a shorter lifespan, reduced egg output and impaired flight are some of the most common symptoms. All in all, being infected with this parasite is bad news for a Monarch, and any way to relieve the parasite burden and disease should be strongly selected for.

Greek God of Healing

As most Monarch enthusiasts know, Monarch caterpillars are specialists on milkweeds. There are well over a hundred species of milkweeds, and Monarchs can use a few dozens of these. Most of the milkweeds that Monarchs feed on are placed in the genus Asclepias. Carolus Linnaeus named this group of plants after the Greek god of medicine and healing, Asclepius, an expert in herbal medicine. This is because he knew that people regularly used milkweeds as herbal medicines. For example, tea extracted from the roots of Common Milkweed has been used as a diuretic and laxative, while the sap is sometimes applied to remove warts. And Butterfly Milkweed has been used as an emetic, a substance used to induce vomiting in order to expel the stomach contents of a patient. Interestingly, it appears that humans are not the only creatures that have discovered the medicinal properties of milkweeds.

Milkweeds have evolved a number of defenses against herbivores. Most famous are the latex sap that looks like milk (hence the name milkweed) and a group of toxic chemicals called cardenolides. Due to these defenses, most animals that eat plants avoid milkweeds. Indeed, the consumption of highly toxic milkweeds can be fatal (even if milkweeds can be used as medicine at lower doses). Monarchs (and about another ten insect species), however, have evolved a great deal of resistance to these milkweed defenses and are therefore able to use them as caterpillar foodplants. For example, Monarch caterpillars on milkweeds bite trenches around themselves and nick the leaf stem to stop the flow of latex into the leaf tissues they are feeding on. In most animals, cardenolides disable the sodium-potassium channels that keep the body’s cells working, but Monarchs have evolved channels that are resistant to the action of these chemicals. This is not to say that Monarchs are perfectly resistant to milkweed defenses (indeed, high amounts of latex and high concentrations of cardenolides are known to be detrimental to Monarchs), but they do generally well enough to survive and reproduce.

One of the most fascinating things about the interaction between milkweeds and Monarchs is that Monarchs have not only evolved resistance against the milkweed’s defenses, but they even hijack these defenses. Instead of simply purging the milkweed’s cardenolides, Monarchs actually concentrate