

Living Cathedrals

SITTING ON THE WOODED HILLSIDE FAR ABOVE THE valley floor, directly across from the butterfly-laden firs, we too were waiting for the sun. We were just a few of the two or three hundred souls in one of the two or three viewing “galleries” at Sierra Chincua, waiting for a sign. As I had been the previous day at El Rosario, I was surprised but also somehow gratified by how many of the onlookers were Mexican. I had envisaged a mob of tourists with cameras, so seeing the local people visiting the sanctuaries impressed me to no end. As we sat and waited, along with the butterflies clustered on the trunks, branches and foliage of the Oyamel firs, I watched both the stunning sight of millions upon millions of Monarchs, resembling (if you didn’t look too close) so many autumn leaves, and the nearly unbelievable sight of children playing and people talking, meeting old friends and playing cards as if they were off at some family picnic.

Personally, I was somewhat insulted. It felt like everyone was talking in church. The wonder of it all was a quasi-religious experience for me; it all but left me speechless and I thought “how rude, to be here amongst the firs with one of the natural wonders of the world, in a living cathedral of trees and butterflies, to spoil the moment by conversing in anything other than the hushed tones and whispers.” The irony of the scientific name of the Oyamel, *Abies religiosa*, was not lost on me. As I leaned back to mention this to my wife, Pat, I watched a leaf fall off one of the branches above me and softly flutter down, waving gently, to land just inches from my feet. When I realized that my “leaf” wasn’t a leaf at all—how could it have been, since the surrounding trees were evergreen firs, and not deciduous at all—but a butterfly, I quite forgot what I was about to say.

I reached over to pick the butterfly up and, realizing that it was still very much alive, placed it on my upraised knee, softly lit by a fleck of the rising sun. Within moments it began shivering and then slowly spread its wings out wide to



The stunning sight of millions upon millions of Monarchs, hanging from fir trees like so many autumn leaves, brings an ever-increasing number of curious butterfly watchers to roosts like El Rosario in Mexico each winter. An estimated 120 million butterflies were found at all of the colonies in the winter of 2001–2002.

bask in the weak sunspot. It was a male and was in such good shape that it appeared to be almost freshly emerged, not at all the battered and torn, faded butterfly that I expected to see. After all, who knew where it had come from, how long its journey had been, how long it had been here, or even how old it was? Within another few moments—between the pale sunshine and the heat radiating off of my knee—it began to barely flex its wings, its wingtips tracing an arc that slowly increased in amplitude until its wings moved quite freely through almost 90 degrees, from the open basking posture to the closed position in which it had fallen off the tree.

When someone called my name, I glanced over to see one of our trip leaders give me a come-along gesture. I gently picked the butterfly off of my knee and gave it to Pat with an admonishment to “take care of the little fellow,” got up, glancing around somewhat guiltily at having disturbed the “service,” and walked over to see what was up. Dan Petr, a colleague from Southwestern Adventist University near Dallas, and John Abbott, a friend, colleague and entomologist from the University of Texas at Austin, had asked one of the “wardens,” locals that acted as both guides and guards, to get us down a little closer to the colony for some photos. John and Dan had been participants on one of the first trips that Tom Emmel, a lepidopterist from the University of Florida at Gainesville, had led to the Monarch’s overwintering grounds and they themselves were here, in homage to Tom, leading their first trip with Pat and I and a dozen other participants along for the ride.

I don’t know if I’ll ever be able to convey the excitement that I felt as we cautiously made our way downslope and then back up a short ways until we were nose to branch with a tree completely covered in butterflies. I still can’t recall if the shortness of breath I was having was due to the exercise I was getting (at an elevation that, frankly, I wasn’t prepared for) or the sheer joy of where I was and what I was doing. As we made our way to a vantage point that would permit photos, I inadvertently brushed a butterfly-laden branch and was horrified to see many of the butterflies fall off of it like so much dandelion fluff in a stiff breeze. I thought I might cry until I remembered the “rescued” male that I had proudly resuscitated on the slopes above. Perhaps these butterflies, too, would survive my clumsiness. I tried to remind myself of just what they had already been through and that they weren’t nearly as fragile as they appeared.

As we took a few photos the sun finally hit the tops of the trees above us and we were soon enveloped in what can only be described as “orange snow.” Looking



The Monarch's overwintering roosts are almost exclusively found in the Oyamel forests of the Sierra Volcanica Transversal, or Transverse Neovolcanic Range of central Mexico. At an average elevation of 2,500 m (8,200 ft), this mountain range includes some of the highest peaks in Mexico.





Monarchs flying in a forest clearing give one the impression that orange snow is falling. Deforestation is a key issue at the Mexican overwintering roost sites. Trees buffer the butterflies from wind, rain, and extremes in temperature. Fewer trees not only mean fewer places to roost, but a weakening of the forest overall.

up we saw thousands of butterflies flying, slipping and gliding through the gaps between the trees with more being added until, finally, I thought I would stop breathing. It wasn't the irruption of butterflies that I had been told about, when the sound of millions of pairs of wings all beating together could be almost deafening, but it was awe-inspiring all the same...

Life in the Trees

Of course, Monarchs do not know, nor much care I imagine, that we find their sojourns in the mountains of central Mexico so magical. The interesting thing is that they're here at all, and in such large numbers.

All of the overwintering roosts or colonies in the states of Michoacan and Mexico are between 70 and 170 km (44–105 mi) west of Mexico City in the Oyamel Fir (*Abies religiosa*, Pinaceae) forests of Mexico's Transverse Neovolcanic Range that lie between 18° and 19°N latitude. At an average elevation of 2,500 m (8,200 ft), but reaching over 3,650 m (12,000 ft) on some peaks, this mountain range includes some of the highest peaks in Mexico. The Oyamel forests, which are preferred almost exclusively by the butterflies, occur in 13 "islands" of vegetation on some of the tallest peaks. Nine of these vegetation islands, which are, ecologically speaking, relict boreal forests which persist at this altitude, occur within the *Sierra Volcanica Transversal*. Five of the ranges within this belt of mountains, covering an area of only 800 sq km (309 sq mi)—the Sierra Campanario, Sierra Chincua, Sierra Chivati, Sierra Pelon and Sierra Picacho—usually have one or more of the overwintering roosts each year.

The Oyamel forests are critical habitat for the overwintering Monarchs. During the summer, when the butterflies are not in residence, these forests are characteristically "cloud forests," damp with fog for much of the day. They harbor a rich herbaceous understory that is somewhat unusual for a "boreal" forest. During the winter the forests provide the conditions necessary to the overwintering butterflies, including moderately cold temperatures that promote torpor but are not lethal, warming during the day to allow activity (but not too much excessively energy-draining activity), and enough humidity to prevent fires and desiccation of the butterflies.

Temperatures under the firs have been shown to be 2° to 5°C (4°–9°F) warmer than in nearby clearings and moderate thinning of the forest canopy



Oyamel Fir (Abies religiosa) forests are critical habitat for the overwintering Monarchs in Mexico. During the winter the trees moderate cold temperatures to promote torpor without being lethal, and provide enough humidity to prevent fires and desiccation. The rich herbaceous understory of the forests also harbors a wealth of winter wildflowers that provide needed nectar resources.

*“Look out for the butterflies!”
Forest clearing and increasing
tourism continue to encroach on
the Monarch’s overwintering sites
despite the Mexican government’s
early decree to set aside some
16,000 hectares (40,000 acres)
as protected areas.*



can reduce the temperature by as much as 2°C (4°F). The temperature buffering ability of the Oyamel forest is excellent with normal ranges being confined to minimums of 6° to 9° C (42°–48°F) and maximums of 13° to 15°C (56°–60°F), a total range of only 4° to 9°C (8°–18°F). The forest understory also has a wealth of winter wildflowers that provide nectar and the valley bottoms contain streams where the butterflies may drink. The slopes of the mountains also allow the roosts to move up or down the slope in concert with the prevailing temperature regimes: roosts often form up high in the early winter but are found further down the slopes by the time winter temperatures drop to dangerous levels.

Trouble in Paradise

The sheer magnitude and incredible scope of its annual autumnal migration have earmarked the Monarch as the poster child of an entirely new class of endangerment, the “endangered phenomenon,” and much has been written in this context of the conservation issues at the overwintering roosts. While I



believe that conservation issues are just as real and of considerable concern throughout the rest of the Monarch's range, I don't wish to downplay issues at the overwintering roosts, so I will dwell on them briefly here.

Without doubt the most critical problems faced in the overwintering roosts are habitat damage and loss. It wasn't until 1976 that the world learned the answer to the riddle of where all those Monarchs went through the disclosure of the general location of overwintering roosts in *National Geographic*. It's important to realize that even then, habitat degradation and loss through forest clearing and tree removal were ongoing problems. These issues prompted many concerned and interested people to lobby the Mexican government for protective legislation. In

Butterflies or leaves? Monarchs will stay in their overwintering roosts for four or five months, and for much of that time many may not move at all, other than to jockey for position among the crowded branches.

ROOST SIZES AND CONSERVATION

Accurately estimating the population size of the half dozen or so main Monarch colonies—more than 30 sites have been identified but occupancy varies substantially among colonies and from year to year—is, as might be expected, difficult. Bill Calvert of Texas Monarch Watch has used two methods—common mark-release-recapture methods and forest parameters such as tree and branch size, density, and counts of butterflies per unit area—and both methods have suggested that there were approximately 13 million butterflies per hectare (about 6 million butterflies per acre). More recently, random samples of dead butterflies on the forest floor after major winter storms have suggested that the density of butterflies varies a great deal between sites but may be as many as 20 to 70 million butterflies per hectare (about 9–32 million butterflies per acre).

The amount of forest cover estimated to be used by Monarchs declined significantly from 7.8 ha (17 acres) in the winter of 1994–95 to 2.3 ha (5 acres) in 2000–01. Using Dr. Calvert's estimate of 13 million butterflies per hectare, this suggests that the total number of butterflies at the roosting sites declined from more than 100 million to only 30 million during this period. However, large year-to-year fluctuations in Monarch numbers are common. The size of the 2001–02 colonies increased remarkably up to an estimated 9.4 ha (21 acres) and about 120 million butterflies. These large

differences in the number of butterflies arriving at the Mexican overwintering roosts strongly suggest that what happens away from the roosts—during the flight north, in the breeding range and the migration south—are also of major importance in the conservation and survival of the eastern North American Monarch.

This is not to imply that conservation efforts at the overwintering roosts are not important. For example, a major winter storm in January of 2002 is estimated to have killed 63 to 73 percent of the 120 million butterflies present, leaving around 40 million butterflies to make the northward journey. This is only slightly higher than the low previous years' estimate of 30 million. As Orley "Chip" Taylor of Monarch Watch observed, it is lucky that the January 2002 storm did not occur a year earlier, when the population was already depressed. A 65 percent mortality event in 2001 would have decimated the overwintering population to leave only about 10 million butterflies to journey north.

Clearly, major climatic events at the overwintering roosts, combined with ongoing concerns such as forest clearing, general global warming and even the effects of tourism, may have a major impact on potential breeding population size. However, the fourfold increase in the numbers of butterflies arriving at the roost sites between 2000 and 2001 also shows the impact and importance of reproductive success in the breeding range.

October of 1986, the Mexican government decreed that five of the known overwintering sites were to be protected by non-disturbance cores surrounded by buffer zones for monitoring loss and damage to the reserves. The original 16,000 ha (40,000 acres) was expanded to 56,000 ha (138,000 acres) by a further decree in November of 2000.

Forest clearing remains an acute problem. Individual Monarch butterflies can survive light freezing temperatures when conditions are relatively dry, and the Oyamel forests are thick and provide excellent forest cover to both buffer drops in temperature and protect the butterflies from precipitation and frost. Obviously, forest clearing removes trees in quantity, and the progression of forest loss in the buffer zones has reduced most of the major roost sites to their core protection zones. The resulting smaller forests have less area and more edge (leading to intrusion by predators that would not normally forage in deep forest) and allow the penetration of wind, rain and storm. Similarly, removing of individual trees within the core protective zones has opened the canopy,

Monarchs drinking on the ground. As spring approaches and the overwintering roosts begin to break up in late February and early March, many Monarchs are nearing the end of their internal reserves and come down from the trees to forage for nectar and water.





Karen Oberhauser, a Monarch researcher from the University of Minnesota, holds male and female Monarchs to show their differences. The male (top) possess two alar pockets (dark spots) on the hindwing that the female (below) lacks.

reduced the temperature- and moisture-buffering capabilities of the forests, and increased the forests' susceptibility to permanent damage from fire.

The real problem, of course, is the same as elsewhere: too many people, not enough employment and not enough resources. The locals depend on the forests for firewood and have been nibbling away at the forests for many years. It's not difficult to see that the conservation problems at the Monarch roosts are not just biological but also legal, sociological and monetary. Most recently, tourism and all of the economic effects that it brings has become a boon, but only to some groups. Others decry tourism as yet another pressure on the forests and the Monarchs.



Two Monarchs mate. As spring progresses, the increasing number of butterflies flying about coupled with the gradual end of reproductive diapause yields an increase in mating activity. Once a female has mated and has begun to mature her eggs, she begins to search for host plants on which to lay them.

Preparing for a Journey

The overwintering roosts begin to break up in late February and early March, although it has been suggested that roost dissolution is happening progressively earlier, possibly caused by global warming trends. Monarchs have been in the roost for four or five months now, and for much of that time some may not have moved at all, other than to jockey for position among the crowded branches. If the temperature and humidity are just so, and the butterflies have been able to conserve their lipid mass during migration and by not being metabolically active, then movement is probably not needed. Others, especially those relegated to the edges of individual groups of butterflies or those that have smaller lipid reserves, make infrequent forays into the air attempting to obtain a more protected position within the colony. But as spring approaches, many of the butterflies are nearing the end of their internal reserves and must forage for nectar and water.

Downslope flights seeking these resources are common in the late morning and afternoons of the weeks preceding roost dissolution. Visitors are often surprised to see butterflies congregated around seeps and runoffs in the lower portions of the roosting areas drinking water, since we so infrequently observe this behavior in most butterflies. In fact, many species of butterflies seek out water, often in the form of dewdrops or unevaporated raindrops on plant leaves, early in the day. Others, of course, obtain moisture indirectly through flower nectar or puddling for mineral salts in moist ground at the edges of streams, ponds and puddles. Still, the numbers of Monarchs that are often found drinking water directly during the early spring or late winter at the roosting colonies often startles many.

Surprisingly, or maybe not so surprisingly, the areas near the roosts have abundant flowers. Roosts form at the elevations that straddle the cusp between too cold and not cold enough and too wet and not humid enough, so the slopes just below the roosts are warmer and wetter and often provide just about perfect conditions for many species of wildflowers. With spring approaching, increasing number of flowers bloom, and more and more Monarchs seek them out to replenish the internal resources that they have slowly but inexorably been depleting by the simple act of staying alive through the winter. The maturation of their reproductive organs as their reproductive diapause slowly ends also uses energy.

The increasing number of butterflies flying about coupled with the gradual end of reproductive diapause yields an increase in mating activity as the season progresses. Monarch mating is unusual among butterflies, even among its closest relatives in the *Danainae*, as the males are quite aggressive. So aggressive, in fact, that they will frequently throw themselves at a suitable object—basically anything around that is the same size, color and shape—grapple with it while the two butterflies fall through the air until they hit the ground, and then hold on tightly while they attempt to copulate. Males seem remarkably poor at being able to identify the opposite sex, however, and frequently attack each other. Fully one-third of the mating attempts and copulations that I saw at El Rosario were male-male pairs locked in “mortal combat.”

Still, enough male-female matings occur that essentially all of the females—the major proportion of which were, by definition through reproductive diapause, virgins—are mated in the days and weeks leading to the dissolution of the colonies. Once a female has mated and has begun to mature her eggs, she



Among butterflies, Monarch mating is unusually aggressive. Males in particular will frequently throw themselves at potential partners. Yet they seem remarkably poor at being able to identify the opposite sex, and frequently attack each other, as shown here.

begins to search for host plants on which to lay them. Why north? Why not just hang around central Mexico and use local milkweeds? These are *big* butterflies, and the average milkweed can only support the complete growth and development of one or two caterpillars. So where do you go when all of the local milkweeds are full? Why, you follow the sun, of course.