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THE OVERWINTERING SITE OF THE EASTERN POPULATION OF THE MONARCH BUTTERFLY (*DANAUS P. PLEXIPPUS*; DANAIDAE) IN SOUTHERN MEXICO

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Twenty-five years have passed since we started an intensive investigation of the movements of the monarch butterfly (*Danaus p. plexippus* (L.)) in North America, although experiments concerned with methods of identifying specimens of a moving population were conducted from 1937–1939. The question to be answered was: "Where is the final destination of the migrating monarchs?"

Over the years we have had the assistance of thousands of volunteers living in various parts of North America. Over 300,000 monarchs were alar tagged (Urquhart, 1960, 1966). In addition, through numerous field expeditions on which we traveled more than 100,000 mi. during the 25-year period, we investigated the presence of monarchs (larvae and imagoes) and the host plants in most parts of southern Canada, the United States, Mexico, and Central America. Some data were obtained as a result of visits to 56 colleges and universities to examine insect and plant collections and discuss the project with our colleagues.

In January 1975, the overwintering colony of the monarch was finally located. We were able to join an expedition in January 1976 to view for ourselves this most spectacular sight—the final southern destination of the eastern population of the migrating monarch butterflies.

Description of Site

The overwintering colony described in the present paper was located on the slope of a volcanic mountain situated in the northern part of the State of Michoacan, Mexico, at a height of slightly over 3,000 m (Fig. 1). The predominant tree, averaging 26 m in height, was the



Fig. 1. A, area over which monarch butterflies of the eastern population are known to breed; B, area of greatest concentration around the Great Lakes; C, overwintering site of the eastern population; D, location of migrants in southeastern Mexico and Guatemala (Urquhart & Urquhart 1976); E, aberrant migration composed of a small portion of the eastern population that reaches the base of the Florida peninsula and continues southward; F, possible route taken by the aberrant Florida migrants. Note: the breeding area of the western population lies within the mountain valleys with overwintering on the California coast.

Oyamel (*Oyamel mexicano* (Dougl.)). The colony occupied an area of roughly 20 acres. The trunks and branches of the Oyamel trees were completely covered with monarchs (Fig. 2)—only small portions of the crowns of the trees were bare as a result of the action of the mountain winds dislodging the butterflies. The monarchs were so closely packed together on the trunks that it was impossible to see even a small portion of the underlying bark. The branches were not only completely covered,



Fig. 2. Clusters of monarch butterflies on three of over a thousand Oyamel trees in the overwintering site. The trunks of the trees are also completely covered. Because of higher temperatures and exposure to the sun through a forest clearing, the monarchs in this photograph have spread their wings. During the evening and throughout the night and early morning, the wings remain closed. Color photographs appear in an article in the *National Geographic Magazine* (August 1976).

from the smallest terminal twig to the base, but the butterflies clung to each other to a depth, in some instances, of 10 cm. One such branch, ca. 2 m in length with a base 4 cm in diam., was so heavily laden with butterflies that it broke, spilling countless thousands of monarchs upon the ground beneath the tree. The forest floor throughout the area was sprinkled with monarchs that, having been dislodged from the trees, were unable to fly because of the low temperatures at this altitude. In some locations the ground was covered to an average depth of 10 cm. It was impossible to walk over the area without crushing hundreds of monarchs underfoot, so, to avoid such wanton destruction, the field party limited its tagging activities to one small area near a forest clearing.

During the early part of our visit (January 7–21) the temperature on the mountain slope varied from a low of -1°C at night and in the early morning to a high of 13°C in the afternoon. During cloudy periods and periods of rain or snow, the daytime temperature remained at an average of 10°C . In the cool periods the monarchs remained inactive with wings closed. With the advent of higher temperatures, many of them, particularly in areas where the sun shone through the Oyamel branches, opened their wings, presenting a magnificent display of color. At such times thousands would take to wing, filling the air over the forest clearing. As the temperature dropped, the monarchs returned to the trees and remained inactive during the night and early morning. Occasionally there was a slight snowfall. Monarchs shaken from the Oyamel branches were found fluttering on the snow surface. With the advent of warmer temperatures, the light snow cover would melt and the monarchs would return—either by flight, in areas where the sun could reach them, or by crawling—to roosting sites—trunks and branches of the Oyamel trees, bushes, or upright dead branches of fallen trees.

To estimate the possible number of monarchs roosting upon one small Oyamel branch, the following procedure was conducted. A small branch, 1.5 m in length, weighed down by its burden of butterflies, was located 2 m from the ground surface. The distance from the ground to the tip of the branch was measured. The roosting monarchs were then removed, which allowed the branch, relieved of its burden, to return to its unweighted position. One end of a cord was tied to the branch, about $\frac{1}{3}$ from the tip, and the other end to a bag. A number of stones were placed in the bag, which caused the tip of the branch to return to its monarch-laden position. On returning to our base, we were able to weigh the bag and its content of stones, which came to 3,800 gm.

Knowing the weight of one butterfly to be 0.61 gm, based on the weight of 50 specimens of both sexes, the estimated number of monarch butterflies on this small branch is calculated to be 6,230. Since over a thousand trees, with branches much larger than the experimental one, together with the trunks and the forest floor, were covered with butterflies, some conception of the number of overwintering monarchs in the area can be imagined. An accurate estimate is, of course impossible, but the numbers would undoubtedly be in the millions.

On our last trip to the site, January 24, the afternoon temperature had risen to 22° C. Thousands of monarchs had left the trees and were flying about, filling the air with fluttering wings, a sight long to be remembered. A number of matings were taking place—pairs flew from one tree to another, and clusters of males and females copulated on the ground. As we climbed the slope of the mountain, we witnessed thousands upon thousands of monarchs heading on a compass bearing of true north. We had witnessed the first spring movement back to the breeding areas of the United States and Canada.

Two members of the field party returned to the site on February 9 to find that an estimated 75% of the butterflies had left the colony. Trees that were previously covered with monarchs were bare.

Predators

A few stray cattle were seen feeding extensively upon the monarchs that were on the ground and the lower portions of the tree trunks. The natives informed us that the cattle commonly fed upon monarchs and grew fat on the diet.

In addition to the predation by cattle, a number of species of birds fed upon the roosting monarchs. We procured one bird (later identified as *Myiarchus tyrannulus*, the Brown-crested Flycatcher) and found its crop and stomach filled with the bodies and a few wing scales of monarchs. The wings of the monarchs had been removed by the birds before ingesting the bodies. It seems reasonable to conclude that other birds did the same thing because the ground was covered with monarch wings that we saw falling from the trees and fluttering to the ground like so many dead leaves.

Tagging Program and Results

Three monarchs that bore our identifying alar tags were recovered at the overwintering sites. During the expedition of January 1975, one specimen tagged in Nevada, Missouri on 9 September 1974 and another tagged in Fredericksburg, Texas on 8 October 1974 were re-

captured. During the January 1976 expedition one specimen tagged at Chaska, Minnesota on 6 September 1975 was recaptured. Such recaptures indicate that the site here described is the overwintering area for the monarch butterflies of the eastern population of North America.

During our field trips to the site, a total of 25,000 specimens were alar tagged. In view of the fact that the specimens at the site were in excellent condition with very little indication of wing fractures, we are confident that tagged monarchs from the overwintering colony will eventually be recaptured at various localities throughout the United States and Canada, thus indicating a return migration for at least a part of the eastern population. Such recaptures will be reported in subsequent publications.

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