



Tracking continent-wide parasite spread in monarch butterflies: Launching a new citizen science project, *MonarchHealth*

Natalie Kolleda and Sonia Altizer, *Institute of Ecology, University of Georgia*



Abstract

Monarch butterflies (*Danaus plexippus*) are ubiquitous in North America and are negatively affected by the protozoan parasite, *Ophryocystis elektroscirrha* (OE). This parasite occurs in all monarch populations examined to date and prevalence varies inversely with host migratory distances, with highest prevalence in populations that breed year round and do not migrate. Monarch butterflies are iconic insects because of their spectacular migration in eastern North America. Multiple citizen science projects involve the public in tracking monarch migratory journeys and in monitoring larval recruitment during the breeding season. In 2006, we launched a new citizen science project, *MonarchHealth*, to recruit volunteers to understand how the prevalence of OE in monarch butterflies varies throughout time and space in the N. American breeding habitat. Almost 100 volunteers from the U.S. and Canada were recruited during our first season. We provided a kit for volunteers to obtain samples from wild-caught monarchs, and return these samples to our laboratory at UGA. We checked for the presence of OE spores using a microscope. Results indicate that about 10% of monarch butterflies were infected with OE during the 2006 breeding season. Prevalence increased toward the end of the breeding season. We will build on experiences during this pilot study and continue to collect data in future years.

Background

The protozoan parasite, *Ophryocystis elektroscirrha* (OE), infects monarch butterflies when caterpillars ingest OE spores deposited on milkweed leaves by adult butterflies. The parasite then travels through the gut wall and replicates, emitting spores on the outside of the adult butterfly following emergence. Previous studies have shown that OE infections cause reduced survival and body size of captive and wild monarch butterflies.

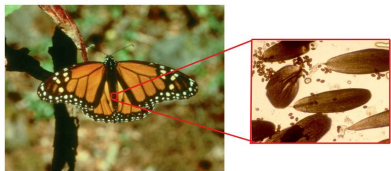


Figure 1. Monarchs infected with *Ophryocystis* parasites harbor dormant spores on the outsides of their bodies, shown in the image to right as smaller objects next to abdominal scales.

Monarch butterflies are found in three main populations in North America. A population east of the Rocky Mountains breeds at low densities (yellow shaded region) and migrates the longest distances to wintering sites in central Mexico. A population west of the Rocky Mountains breeds in the orange shaded region and migrates a shorter distance to coastal CA. A population in S. FL breeds year-round at high densities and does not migrate.

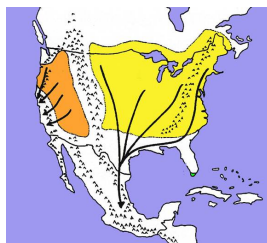


Figure 2. Breeding ranges and migratory routes of N. American monarch populations.

Parasite prevalence varies dramatically among wild monarch populations and is inversely related to host migratory distances. Only 8% of the eastern migratory population is heavily infected, about 30% of the western migratory population is infected, and nearly 80% of the resident S. FL population is infected. A major question involves the role of host migratory behavior in mediating disease spread. Specifically, migration could allow hosts to periodically escape habitats where parasites accumulate over time, and migration could also weed infected animals from the population.

Rationale for the project

Monarch butterflies are iconic insects and several citizen science projects involve the public in collecting data on monarch butterfly migration and reproduction in N. America, allowing us to build on an existing network of volunteers. To better understand processes that affect variation in prevalence within monarch butterfly populations, we asked volunteer observers to help us sample large numbers of monarchs from across North America. Specifically, we predicted that *within N. America, prevalence of OE will increase during the breeding season following transmission from adults to larvae. We also predicted that prevalence will show latitudinal variation, with a higher proportion of infected butterflies at southerly latitudes, particularly if heavily infected butterflies are unable to reach the extreme north of their breeding range.*

Goals

- Recruit 50-100 citizen scientists from the U.S. and Canada to sample wild monarch butterflies for the breeding season of 2006.
- Process samples from volunteers and post results on the Internet.
- Utilize the data from *MonarchHealth* to increase our knowledge of how the prevalence of OE varies with time and space throughout North America.

Methods

- To recruit volunteers for *MonarchHealth*, we sent letters, emails and brochures to nature centers, monarch butterfly organizations, and to the leaders of other monarch citizen scientist projects.
- We developed a basic kit to provide volunteers with materials they would need to sample OE in wild monarchs. With these kits, a set of detailed instructions was provided to help make the process uniform.

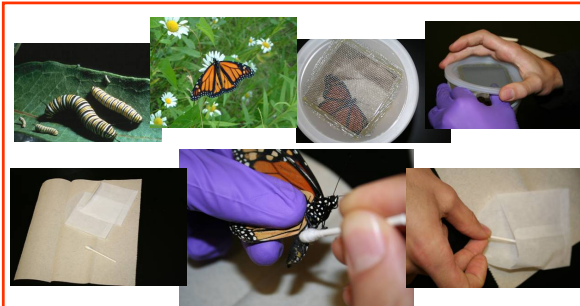


Figure 3. Volunteer protocols for *MonarchHealth* sample collection. Volunteers first capture a wild monarch adult or rear monarch larvae using materials provided in the kits. Adult butterflies were sampled using a swabbing technique, as shown above, to remove butterfly scales and parasite spores from the adults' abdomens. For each sample, volunteers recorded their name, date captured, date sampled, sex, location, and any additional observations or notes.

- Once the breeding season had ended, samples were returned to our lab at UGA for analysis. Swabs were rubbed onto index cards and covered with clear tape. The taped samples were viewed under a stereomicroscope at 60x magnification. Healthy samples showed butterfly scales only but no parasite spores, whereas infected samples showed both spores and scales (Figure 1). We scored infection status on a scale of 0 to 3, with 3 representing the highest density of parasite spores in the samples.

Results



Figure 4. Red points show locations of *MonarchHealth*'s 91 volunteers for 2006.

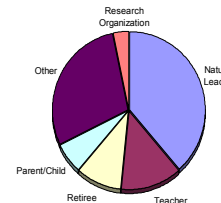


Figure 5. Affiliations of volunteers who submitted samples in 2006.

A total of 91 volunteers signed up to participate in the 2006 pilot season of *MonarchHealth* and were sent kits for data collection (Figure 4). By December 2006, we received samples from 55 volunteers. Of these, most were located in the southeast (N = 118), northeast (N = 82) or midwest (N = 246). The majority of volunteers who submitted data were associated with a nature center, environmental group, school teacher or parent-child combination (Figure 5). However, many of the participants were simply interested in monarch butterflies. We examined a total of 460 samples across all volunteer locations. Most of these were from monarchs collected from the wild as larvae and reared by volunteers.

Results showed that 12% of monarchs were infected with *O. elektroscirrha*. Most infected monarchs were in categories 2 and 3 (87%). The proportion of infected butterflies increased over time throughout the breeding season. Prevalence late in the summer was highest in the Northeast.

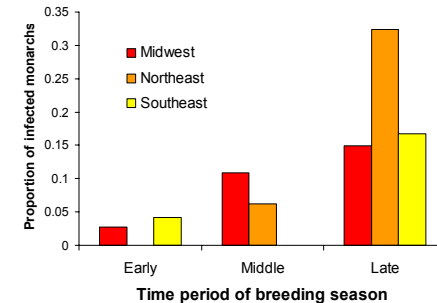


Figure 6. Proportion of infected monarchs by region of the US and time of breeding season: early (April-June), middle (July-mid-August) and late (mid August-October). Number of samples per region per time period ranged from 0 to 121.

Conclusions

- Our 2006 pilot season was successful in recruiting volunteers and obtaining data on the prevalence of OE in wild monarch butterflies.
- Proportions of infected monarchs during the summer breeding period will be compared with samples from wintering monarchs in Mexico.
- We look forward to expanding this project in 2007 with more volunteers, more samples, and slightly different protocols.



Acknowledgements: We thank Jaap de Roode with help in designing this project as well as all of the *MonarchHealth* volunteers for collecting data. This work was supported by the University of Georgia Faculty Research Grant to Sonia Altizer.