**Supplementary Appendix 1**

*Host plant propagation*

Seeds of six species of milkweed were collected with permits from around the world between 2015-2018. Milkweed species were chosen in accordance with (1) their prevalence as host plants for monarchs from each region and (2) to maximize representation within the milkweed phylogeny (see Agrawal and Fishbein 2008 and Appendix 1). When possible, seeds were collected by fruit, which ensures full-sib relatedness among fruit-mates due to their pollination biology (Wyatt and Broyles 1994). Seeds were stored either at room temperature or were cold stratified, depending on their germination requirements. In 2017, we used only four milkweed species (*Asclepias fascicularis* [ASFA – Western North America], *Asclepias syriaca* [ASYR – Eastern North America], *Asclepias curassavica* [ASCU – Guam], *Gomphocarpus physocarpus* [GOPH – Australia and Hawaii]); in 2018, we grew the same four species as well as two additional species (*Asclepias speciosa* [ASPEC – Western North America], *Asclepias incarnata* [AINC – Eastern North America]).

Beginning in February (2017) and March (2018) through September, plants were grown from seed and transplanted into 1 gallon plastic pots in UC Soil Mix media, in two greenhouses. Large pots and fertilization produced large plants capable of supporting multiple caterpillars, a situation sometimes encountered in the field (pers. obs.). Plants (N=634 total across years) were grown in a completely randomized design under ambient light (long days) and at 28**°**C in the same two greenhouses. Approximately one quarter of plants (157/634) were used in multiple feeding trials during the experiment because of limited sample sizes in some species; in these cases, we waited at least three weeks before applying new caterpillars to a plant that had already been used in a feeding trial.

*Monarch butterfly collection*

Monarchs from 16 sites were collected with permits as live adult females from their respective locations and transported to Davis, CA in glassine envelopes. In some cases, adults could not be collected in sufficient numbers, and so larvae were collected and reared to eclosion instead. In these cases, larvae were collected over a broad spatial (i.e. separate plants and separate sites) and temporal range (i.e. different developmental stages) to minimize the chance of sampling full or half sibs. Monarchs were kept alive as adults in glassine envelopes and fed a 5:1 water : honey mixture daily. For adult butterflies reared from larvae, we used hand-pairing to achieve mating within populations (Clarke and Sheppard 1956), with care taken to minimize the chance of crosses between potential sibs (Mongue *et al*. 2016). Field-collected adult females used for oviposition were sometimes infected with the protozoan parasite *Ophryocystis elektroschirrha* (OE), with infection rates generally reflecting those that occur in naturally migratory and non-migratory populations (Altizer *et al.* 2000). In 2017, we used butterflies from four populations (eastern North America [ENA], western North America [CA], Hawaii [HI], Australia [AU]); in 2018 we used the same four populations as well as two additional populations (Guam [GU] and Puerto Rico [PR]).

Adult females were set up in oviposition cages with *A. curassavica* for ~24 hours to produce eggs that were used in the experiment, and females typically produced 20-100 eggs per 24 hours. Eggs were collected at the end of each 24 hour period and transferred to labelled petri dishes with a damp paper towel and a small number of *A. curassavica* leaves. These petri dishes were then stored either in the greenhouse or a lab benchtop, with water added as necessary to prevent leaves from drying out. As soon as the eggs reached the “black head” stage (Zalucki *et al.* 2001), petri dishes were checked every 12 hours for emergence, and within 24 hours of hatching, neonates were transferred onto their respective experimental host plants.

*Experimental design and data collection*

We reared caterpillars in a fully factorial design, with all monarch populations reared on all potential host species. When possible, we further stratified this design across individual maternal families. Because of the logistical challenges associated with having all populations developing concurrently, the experiment was carried out over the course of approximately three months in both 2017 and 2018. Since host plants were also continuously growing and potentially changing in condition during this time frame, we reared at least one monarch population over the duration of the experiment in both years in an attempt to account for possible temporal effects (see Figure S1) and also included a model term for plant age in all statistical analyses (see below).

As soon as neonates hatched, they were randomly assigned to an individual plant. We placed between 1-5 neonates per plant depending on their availability, though 85% of plants received the full complement of five neonates (see Table S4). Neonates were transferred with a fine paintbrush onto newly expanded leaves at the top of each plant. Plants were then fully enclosed using custom-made polyester Super-Aire™ sleeves (A-Roo LLC), with the bottom end sealed using a metal twist tie and the top sealed with binder clips (see Figure S2). In total, we set up approximately 4,000 neonate caterpillars over the course of the experiment.

Neonates were left to grow for eight days and then scored for survival and weighed; almost all larval mortality in monarchs occurs within this window (Zalucki and Malcolm 1999, Zalucki *et al.* 2001). Any surviving larvae that could be found were put into petri dishes and weighed to the nearest milligram. Larvae that could not be found were assumed to have died during their early development; in some cases we found the remains of first instar caterpillars. If plants were large enough, all surviving larvae were returned. If not, we used a random number generator to select which larvae to return to the plant.

After caterpillars reached their fifth and final instar, plants were checked daily to capture dates of pupation. Pupae were transferred into individually labeled 16 oz containers; on the day of eclosion, adult butterflies were kept in the container in which they eclosed for 6-8 hours to allow their wings to dry, at which point they were transferred into a glassine envelope and frozen.

References

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