Monarch Class Data

Emma Lastine, FWCB 1901, Fall 2004

Question:

How does larval development time affect adult monarch mass and does gender correlate with development time?

Hypotheses:

Question 1:

1. Null hypothesis: there is no difference between the mass of an adult monarch that spent 13 days as a larvae or one that spent 16 days as a larvae.
2. The longer the development the larger the adult mass will be; larvae have more time to consume milkweed.
3. The longer the development, the smaller the adult mass; larvae may have developmental problems.

Question 2:

4. Null hypothesis: there is no relationship between development time and gender.
5. Male monarchs are larger. They may achieve this large size by taking longer to complete the larval stage. This predicts that male monarchs have a longer development time.

Methods:

The monarchs were kept in 4 cages about the size of a shoe box. Each cage held 12 monarch larvae. The monarchs were kept in an incubator at 12 degrees C from the day after they emerged to the day they were weighed (about five days later). Starting on September 13, 2004, the larvae were weighed in grams and their instar was recorded every day. Milkweed was replaced with a new stock when it became old and dried out. Later, starting at the j-date, each individual monarch was tracked. Each larvae had its pupation date, date of emergence, adult mass and gender recorded. I then looked at relationships between total larva time, total development time, adult mass and gender. I used ANOVA tests to compare the masses of butterflies that were larvae for different numbers of days and to compare larval development time in male and female monarchs. I also used a Tukey HSD test to determine which groups were significantly different that others.

Data:

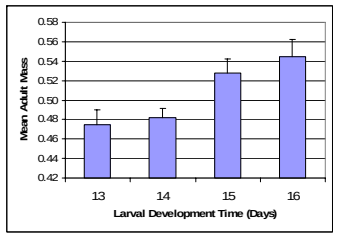

Figure 1 shows the adult mean mass for total days spent as a larva. ANOVA F=5.54, df=37, p=0.0033.

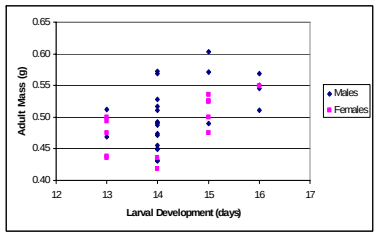

Figure 2 shows the differences between male and female monarch adult masses for total days spent as larvae.

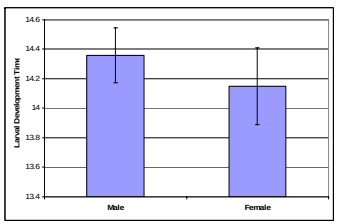

Figure 3 compares male and female mean larval development time. ANOVA F=.42, df=37, p=0.5230.

Results:

There were significant correlations between total development time, larval development and mass. There is a higher correlation between larval development time and mass. Further analysis was conducted on this correlation. There is a difference between monarchs that spent different amounts of time as larvae (Figure 1). Monarch that spent 13 days as larvae weighed significantly less than those that spent 16 days as larvae and monarchs that spent 14 days as larvae were significantly less than monarchs that spent 15 and 16 days as larvae (Tukey HSD test). There was no significant difference in larval development time between male and female monarchs (see Figure 2). Males had a mean development time of 14.36 $\pm$ 0.19 days and females had a mean development time of 14.15 $\pm$ 0.26 days (Figure 3). The null hypothesis for question two can not be rejected.

Conclusions:

I supported my second hypothesis in question one. Larvae were able to achieve greater mass by eating milkweed over a longer time. This was proven by a one-way AOV for mass by larva time. Larvae that took longer to develop turned into larger adults. In comparison to a paper written by Lavoie and Oberhauser, I found that I had an unusually long development time. Their larvae averaged 13.3 $\pm$ 0.09 days in a high nitrogen treatment and 13.2 $\pm$ 0.06 days in a low nitrogen treatment. That experiment began with eggs and I started with second in-stars. It might have been their different treatment that accounted for this longer development time. However, even though males tend to be larger than females, males did not take longer to develop. This may be a result of the sample size. I had 24 male monarchs and 12 female monarchs; this could have off set the means to give a large p-value. It is a possibility that males have something that females don't have to increase their mass. Further research will need to be conducted again with a larger sample size and an equal ratio of male to female monarchs to see if the results differ. Males were bigger than females although it was not statistically significant, but they did not take longer to develop even thought there was a relationship between development time and mass. The Evolution of Incest Mating Systems has a chapter about Protandry, with in that chapter, L. D. Marshall hypothesized "if large size is achieved at the expense of prolonging the larval stage, then insects that emerge sooner will be smaller than later-emerging ones." It is possible that males take longer to develop to become larger and gain fertility to ensure that their genes are passed on to the next generation.

References:

Lavoine, Bethann and Oberhauser, Karen S. "Compensatory Feeding in *Danaus plexippus* (Lepidoptera: Nymphalidae) in Response to Variation in Host Plant Quality." Environment Entomology 33(2004): 1062-1069.

Thornhill, Randy and Alcock, John. The Evolution of Insect Mating Systems. Cambridge, Massachusetts, and London, England: Harvard University Press, 1983.

Oberhauser, Karen, personal communication

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