Emergence Times of Adult Monarch Butterflies

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Questions:

1.) In what stage do monarchs develop their biological clock?

2.) Do monarchs use light as a signal to tell them when to emerge?

Hypotheses:

H_o: The pupae do not follow the clock shift. (The clock shifted group emerges at about the same time as the control group.)

H_a: The pupae follow the clock shift. (The clock shifted group emerges approximately six hours after the control group.)

Methods:

•Started out with 45 first instar larvae.
•15 on each plant, 5/leaf: each plant is a treatment.
•Experienced high mortality, so only two treatments remained despite adding more larvae.
•All remaining larvae were in one cage with potted milkweed.
•When they were 1-2 days away from pupating, larvae were placed in a smaller plastic container with fresh cut milkweed in floral tubes.
•After larvae pupated, they were randomly allocated to one of the incubators:
  •Control (Lights on at 6am, off at 8pm)
  •Clock Shift (Lights on at 12pm, off at 2am)
•Pupae were monitored closely after they were getting dark, indicating they were less than a day away from emerging.
•The time that they emerged was noted, (or as close as I could get to the actual time) and the butterfly was removed from the incubator after its wings had hardened.

Butterfly #	Pupated	Emerged	Sex
Control			
1	20-Nov	30-Nov Before 8:00 am	F
2	20-Nov	29-Nov Before 8:20 am	F
3	21-Nov	30-Nov Before 8:00 am	F
4	21-Nov	30-Nov Before 8:00 am	F
5	25-Nov	2-Dec Before 8:15 am	M
6	2-Dec		
7	2-Dec		
Clock Shift			
1	22-Nov	30-Nov Between 8am & 12:50pm	F
2	23-Nov	30-Nov Between 8am & 12:50pm	M
3	23-Nov	30-Nov at 3:05	M
4	28-Nov	6-Dec Between 10:30am & 1:15pm	F
5	28-Nov	6-Dec Between 10:30am & 1:15pm	F
6	28-Nov	5-Dec at 12:05 pm	F
7	29-Nov	6-Dec Between 10:30am & 1:15pm	M
8	29-Nov	6-Dec Between 10:30am & 1:15pm	F
9	2-Dec		
10	2-Dec		
11	3-Dec		

Source: http://www.tpwd.state.tx.us/expltx/eft/urban/lrgvbfly2.htm

Results: By looking at the chart, it appears that the larvae followed the clock shift. A t-test backs up this statement. Using the latest times, (12:50 instead of 8 in Butterfly #1, for example) I got a P-value ~.002394, making these results significant.

Conclusions: This whole project was based on the fact that monarchs tend to emerge after dawn (Scott, 1986) and the control data support that. Furthermore, the clock shifted data indicate that the larvae's biological clock has not already been "set" when it has pupated. Butterflies have a photoreceptor in the genitalia which doesn't form until the second half of pupal development. (Miyako, 1995.) This is one direction this research could go next; pinpointing when this photoreceptor forms, which could help answer the question as to when and how monarchs "set" their clocks. Another direction could be getting a better idea of the circadian clock. Any future research in this area should include some sort of camera to get more accurate emergence times, which was the largest source of error in this project.

References:

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