Migratory immunity: parasite infection, host defense and fitness costs in monarch butterflies

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Parasitism/disease is common in wild monarchs.

Monarchs can express resistance/defense but susceptibility remains high.
• What determines variation in susceptibility to infection?

• How does migration affect the costs of infection and investment in immunity?
Ophryocystis elektroscirrha
Apicomplexan (protozoan)
High variation in host resistance

What determines susceptibility to infection by OE?
Innate immune defenses

Hemocytes: cellular immunity

Phenoloxidase: melanization

23.5 Light micrograph of melanized oocyst of Plasmodium gallinaceum on the midgut of Aedes aegypti
Older larva are more resistant to OE

Young larvae highly susceptible to infection

Older monarchs had low infectivity and low average spore loads

Altizer, S., DeRoode, J. and Strand, M. Unpublished data
Older larvae have greater innate immune defenses

Hemocyte concentrations & PO activity increase with larval age

More hemocytes = lower parasite loads and higher survival

Altizer, S., DeRoode, J. and Strand, M. Unpublished data
Migration increases the cost of OE infection

- Parasitized monarchs fly less well
- Prevalence decreases as monarch move south
- Prevalence lower at overwintering sites
- Healthy overwintering monarchs originate from farther north than infected monarchs (stable isotope analysis)

Does migration also increase the costs of immunity?
Tradeoff between lipids and immunity

Dara Satterfield: poster on lipids, OE and immune defense
Diapause and immune defense

- Do migrating monarchs divert resources away from costly immunity....

- or do they invest more to protect against infection?
Diapause and immune defense

- 800 larvae
- Summer vs. diapause conditions
- OE infection and controls
- Sampled immune defense (larva, pupa, adult)
- Infection status, size, survival
- Reproductive status
No effect of diapause on immunity

- Hemocyte concentrations and PO activity similar for all treatment groups
100% infection among inoculated monarchs

Pupal examination: high spore loads
Higher survival and lower deformity in diapause treatment

*Diapause increases resistance or tolerance to infection*

![Bar chart showing higher survival and lower deformity in diapause treatment](chart.png)

- **Proportion surviving to adult**
  - Healthy
  - Infected

**Diapause induction treatment**

- Summer
- Diapause

- Adult lifespan (days)
• Parasite infections costly for migrating monarchs

• Tradeoff between lipids and immune defense

• Diapause induction: no difference in innate immunity

• Some protection from the negative effects of infection
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