Insects and climate change:

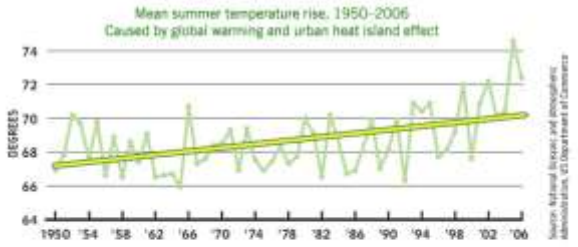
Models for evolution

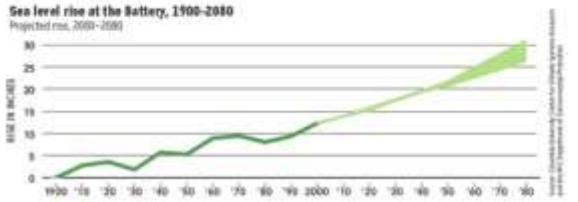
Hahn Lab

University of Florida

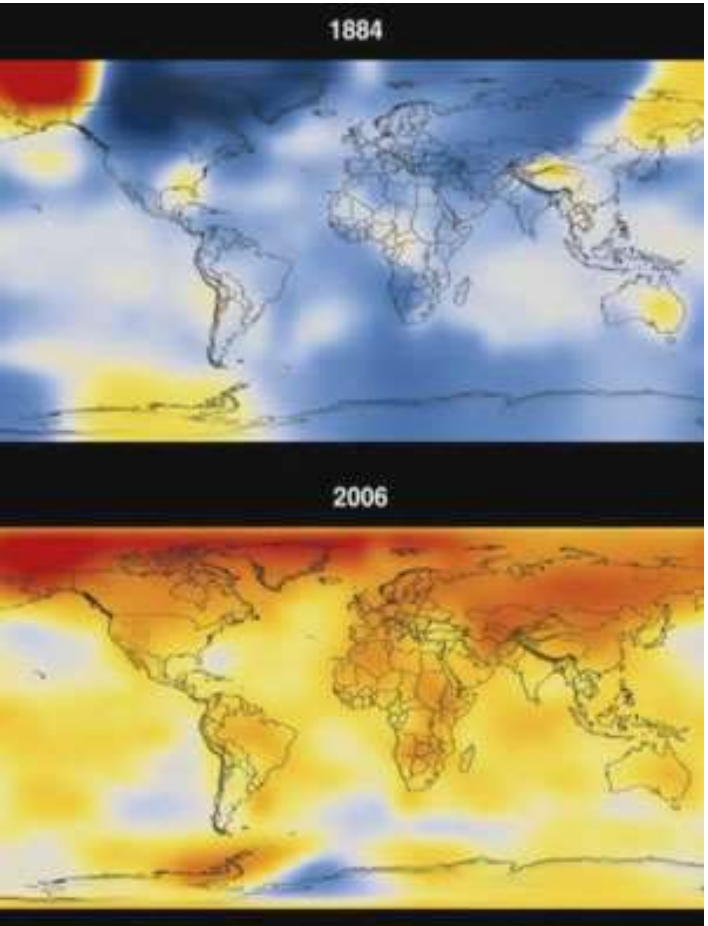




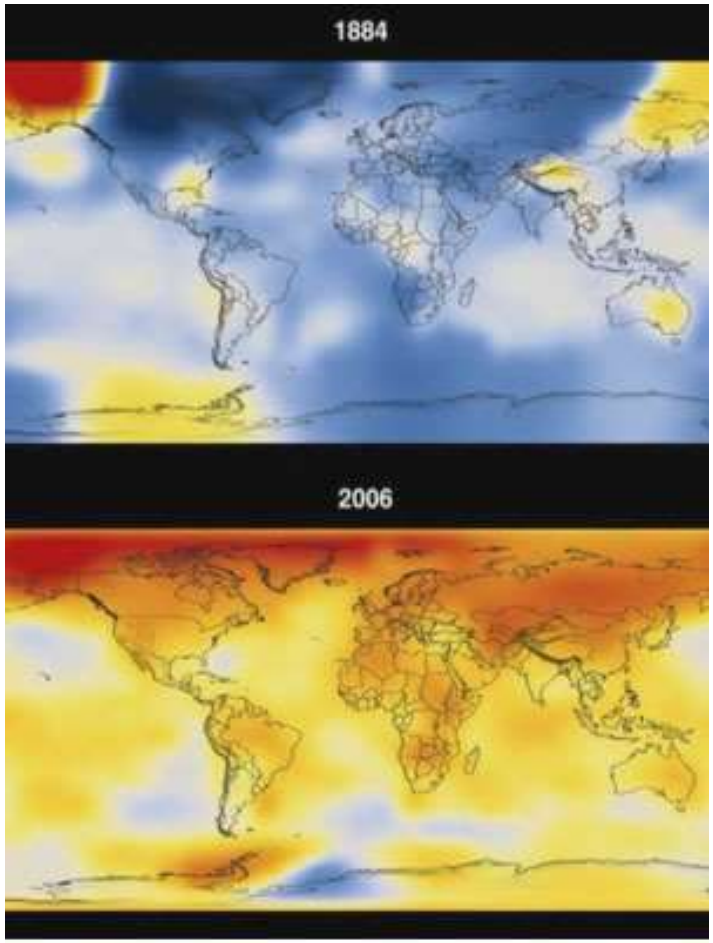




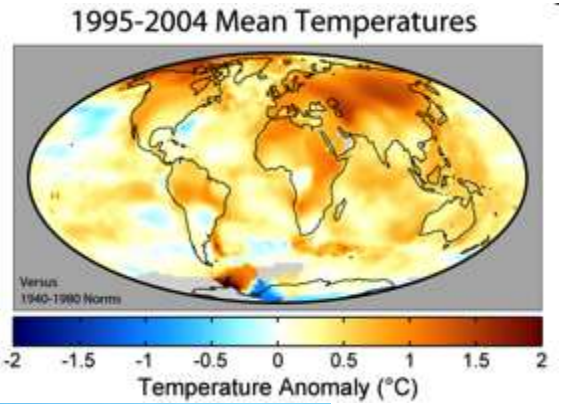
Climate Change

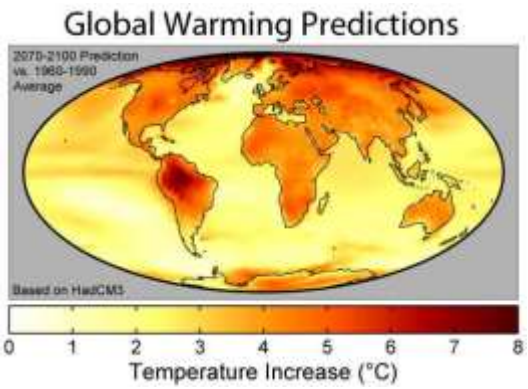


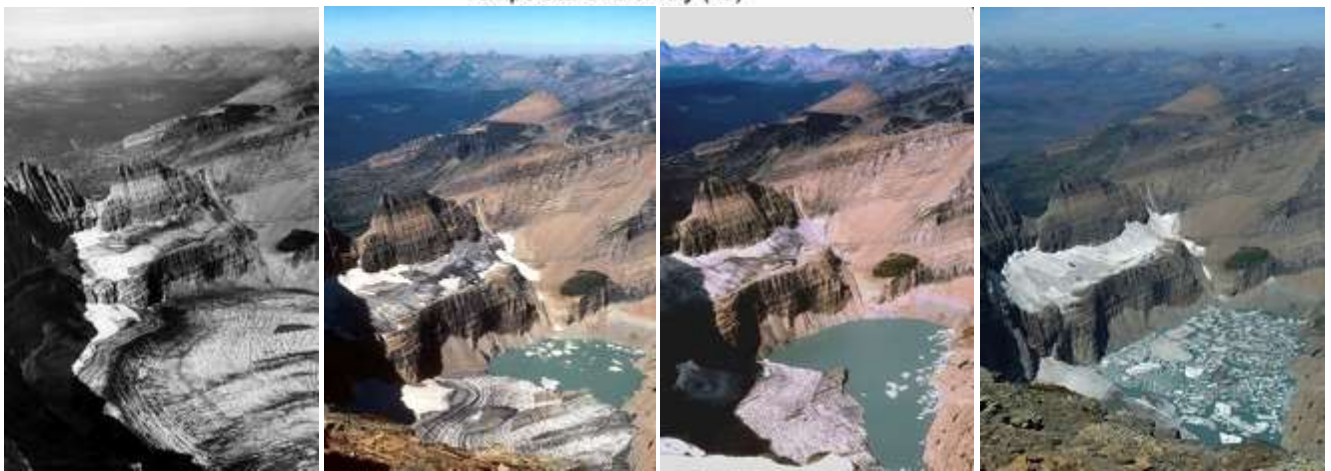
What do you currently know about climate change?



Global Change = shifting phenologies & more extreme events



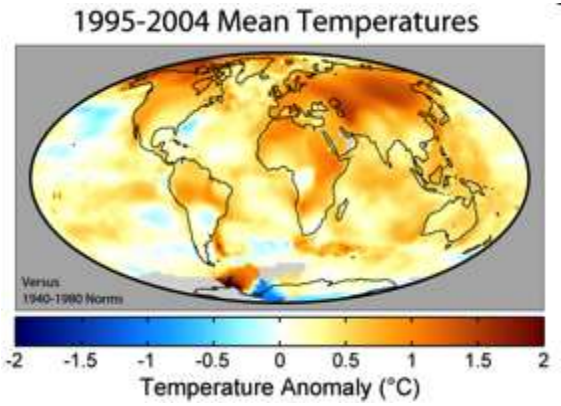


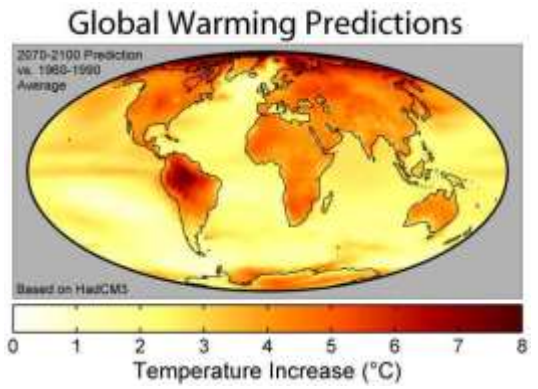


Global Change = shifting phenologies & more extreme events

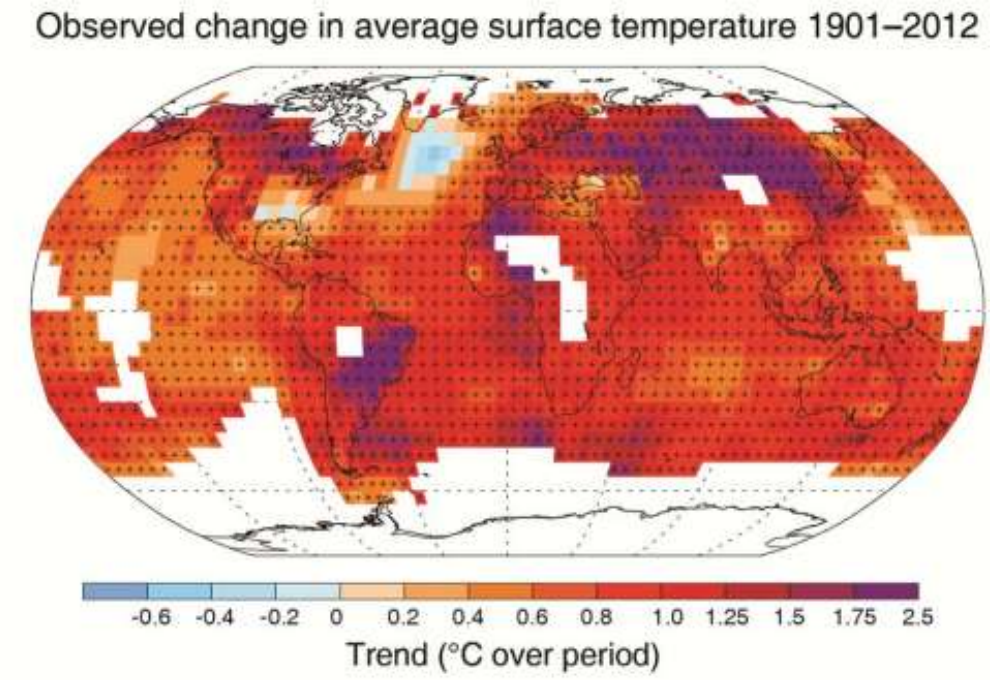
Predict increased tolerance to both heat and hot-cold Swings

Cold tolerance?





The Relevance of Climate Change to Ectotherms



Insects have many significant roles in ecosystems


(Martin Ruegner/Getty)

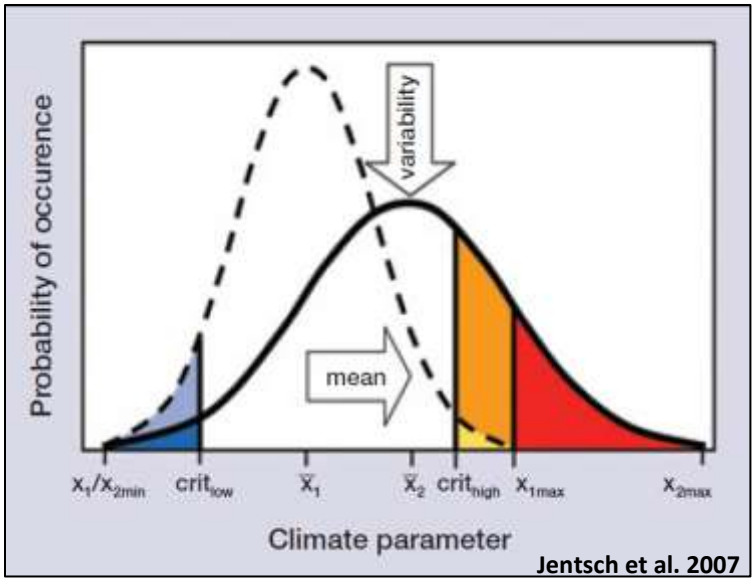

(Christina Matheson)


(Jon Brierley)

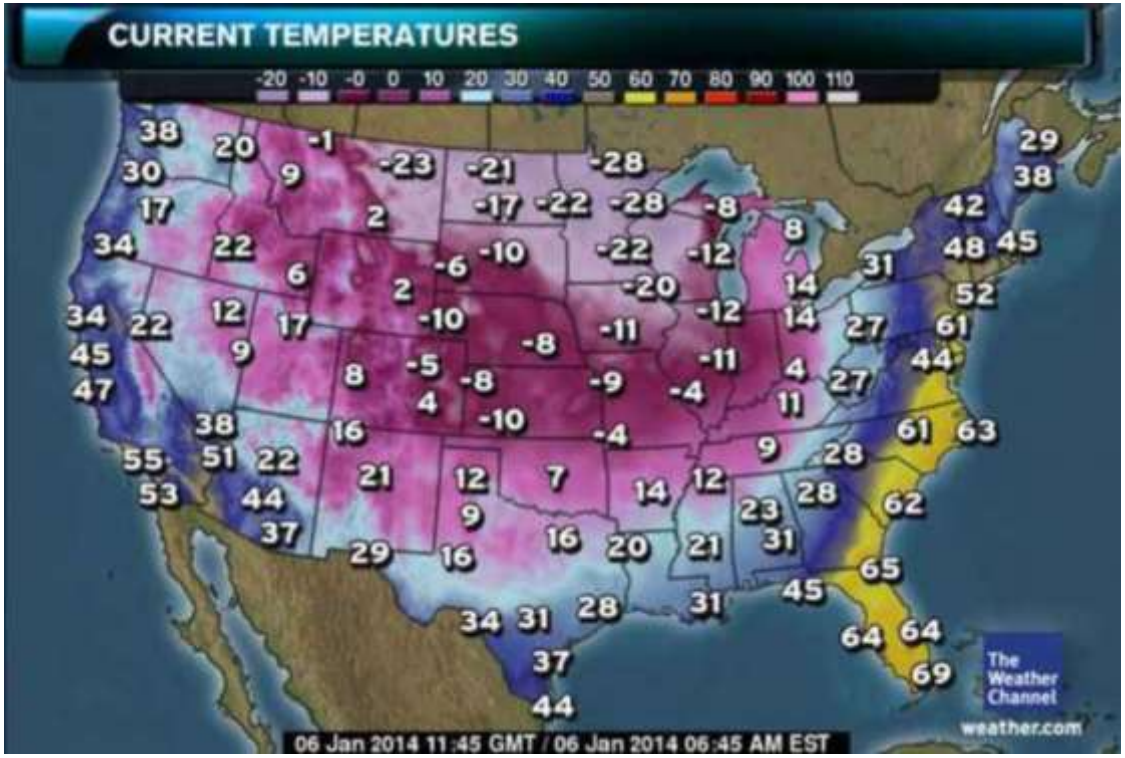

(John Meyer)

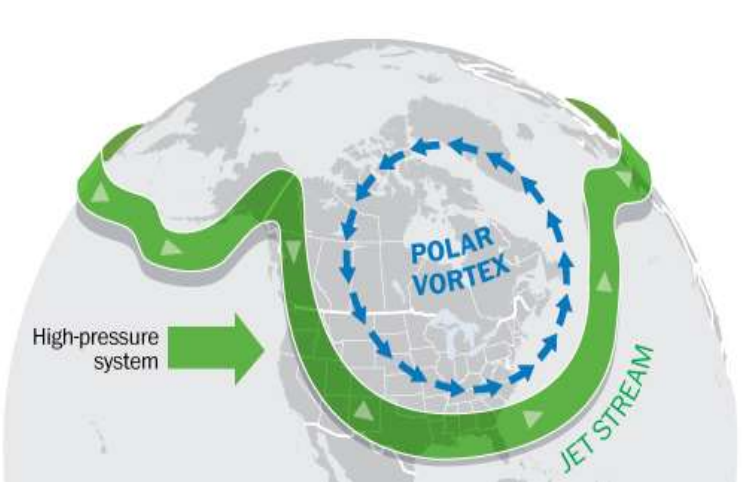

(Solvin Zankl)

Increased Variability of Temperatures



Jentsch et al. 2007





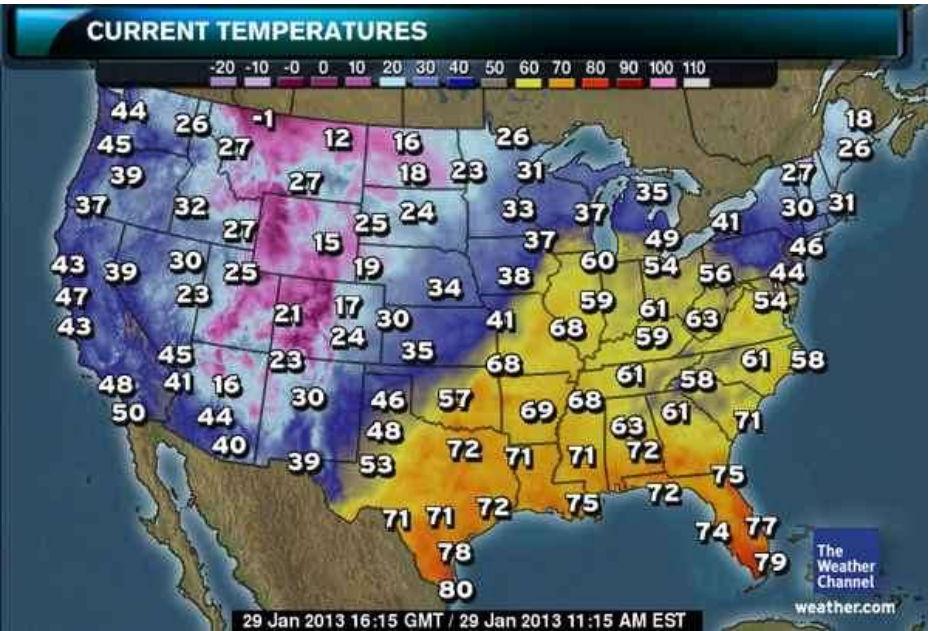
Bonnie Berkowitz, Richard Johnson, Katie Park, and Gene Thorp - The Washington Post.

Strategies for dealing with a warming climate

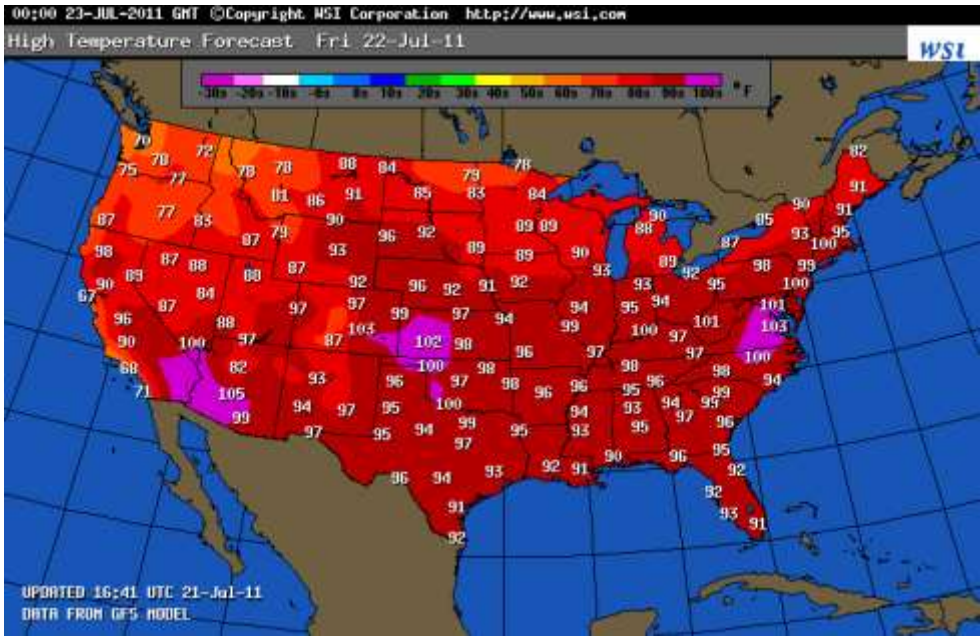
How might animals respond to:

- **warmer temperatures?**
- **shorter winters?**

Winter temps very different



Summer temps not so different



Coping with seasonal environmental variation: Evolutionary strategies

1. **Avoidance responses**
   - Permanent escape in space (migration)
   - Temporary escape in space (migration)
   - Temporary escape in time (dormancy)
2. **Direct responses**
   - Flexible phenotypes
   - Stress tolerance

Hibernate/migrate to avoid bad times and exploit good times.

Range changes in European butterflies

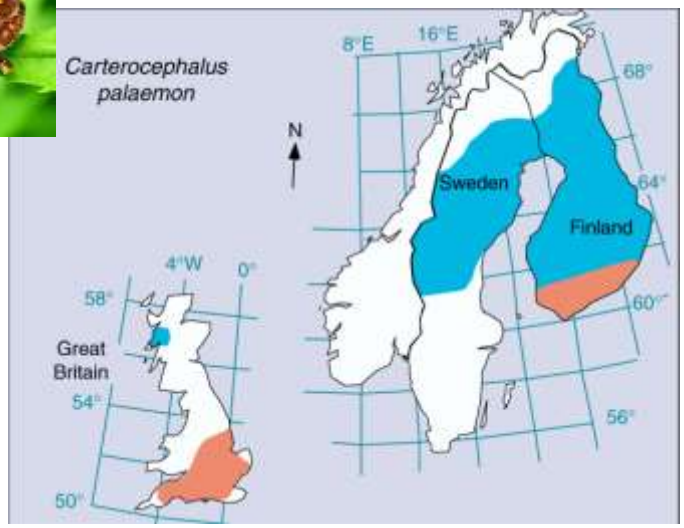
Argynnis paphia

Pararge aegeria

Carterocephalus palaemon

Heodes tityrus

Range changes in European butterflies

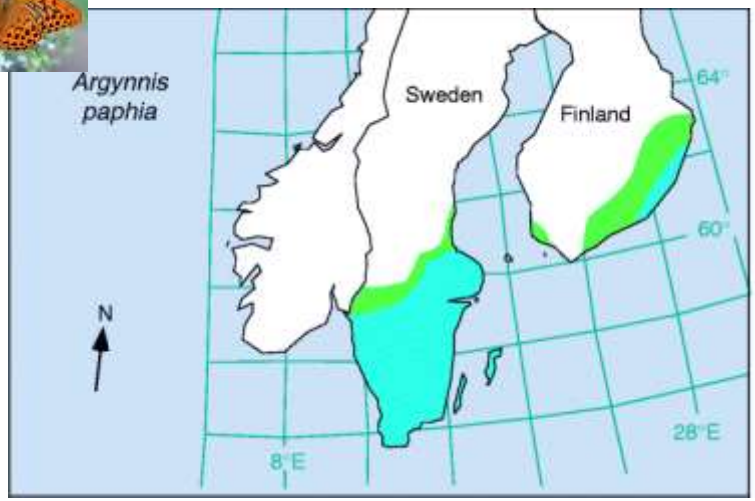


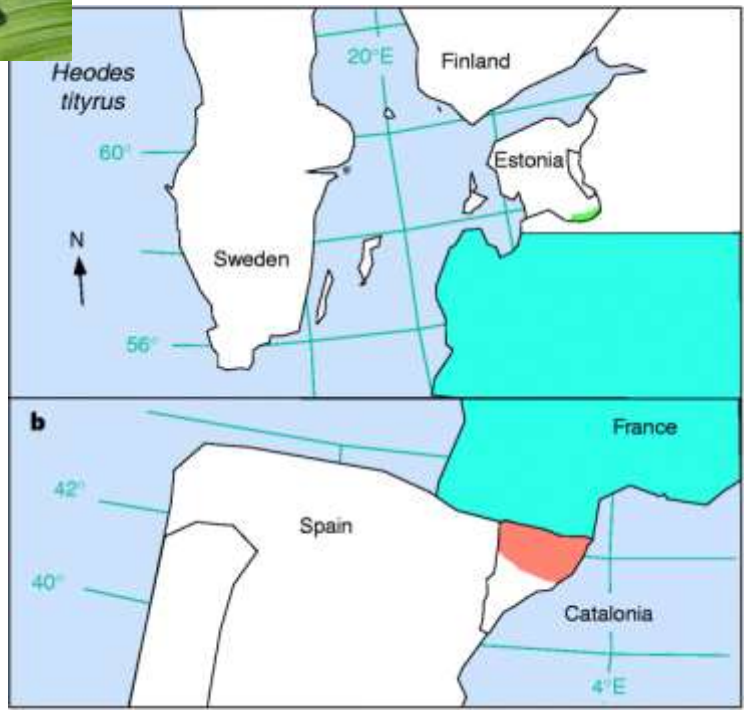
1900 - 1920

1920 - 1999

1990 - 1998

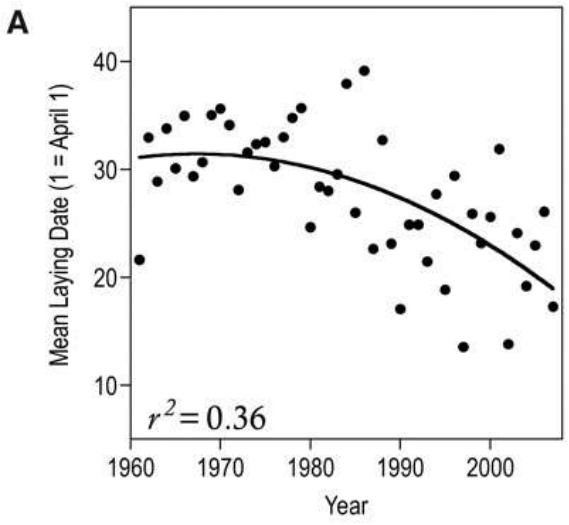
= +

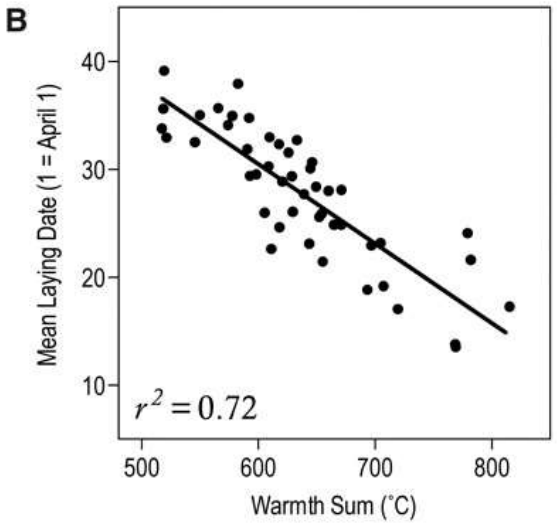


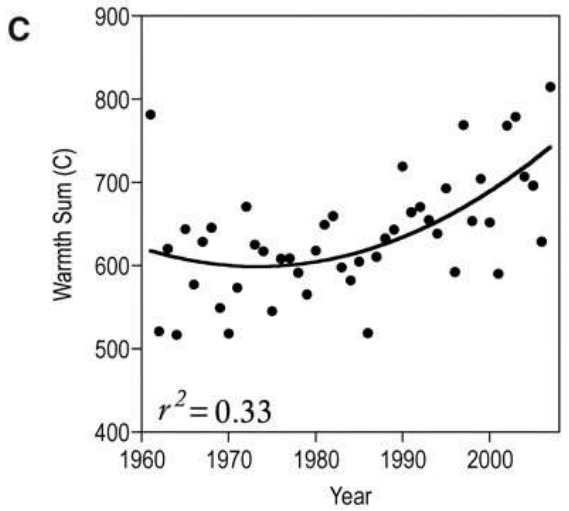


Parmesan et al., 1999

Life history responses: breeding time, why is it changing?



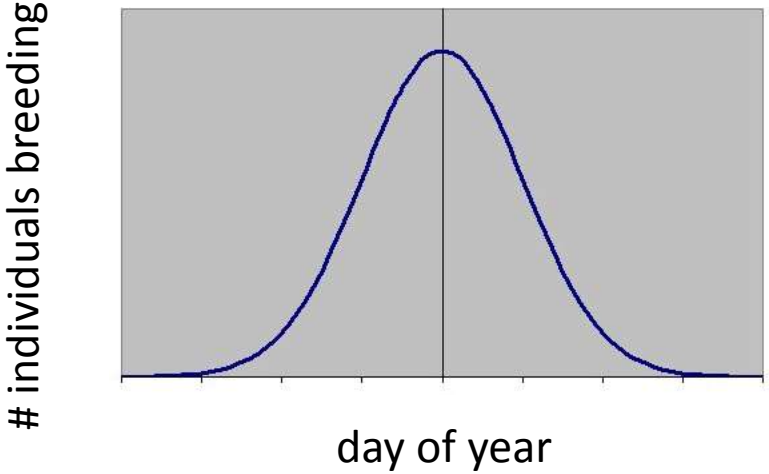


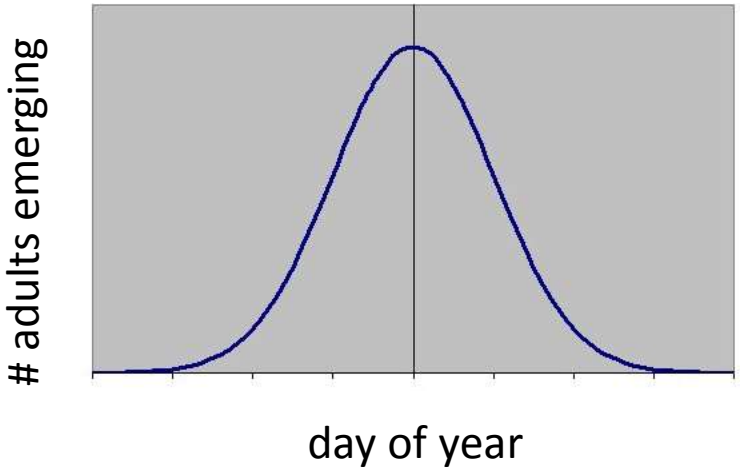


Parus major (Great Tit)

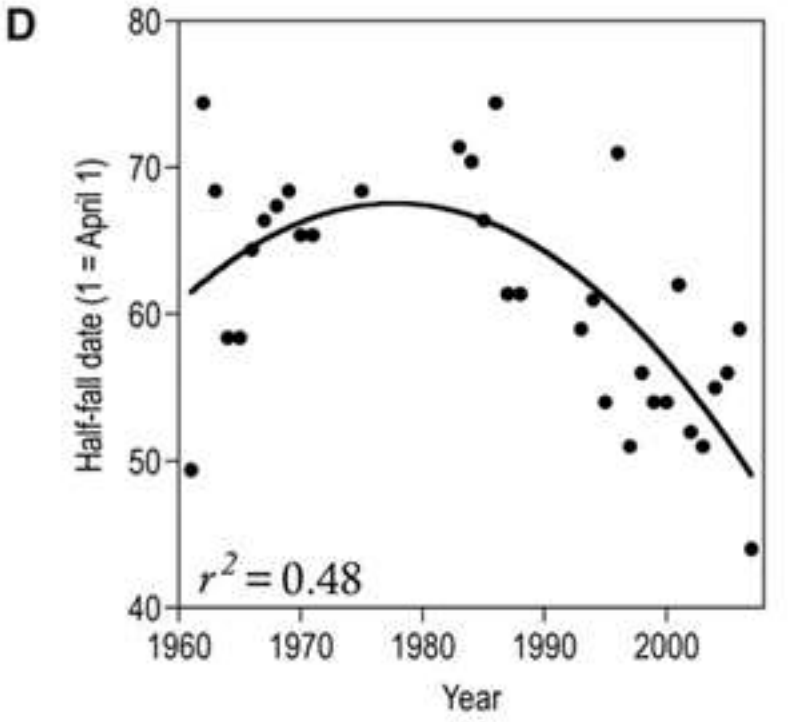
Resource availability

Operophtera brumata
(Winter moth)





Moth life history response: emergence timing to match oak buds and fresh, tender leaves

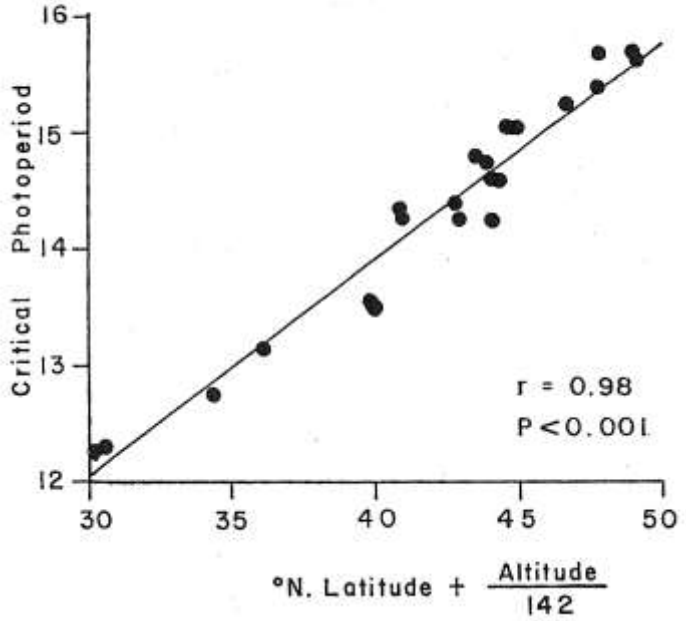


Weomyia smithii

- Broad latitudinal and altitudinal range
- Photoperiod-induced larval dormancy (3rd or 4th instar)

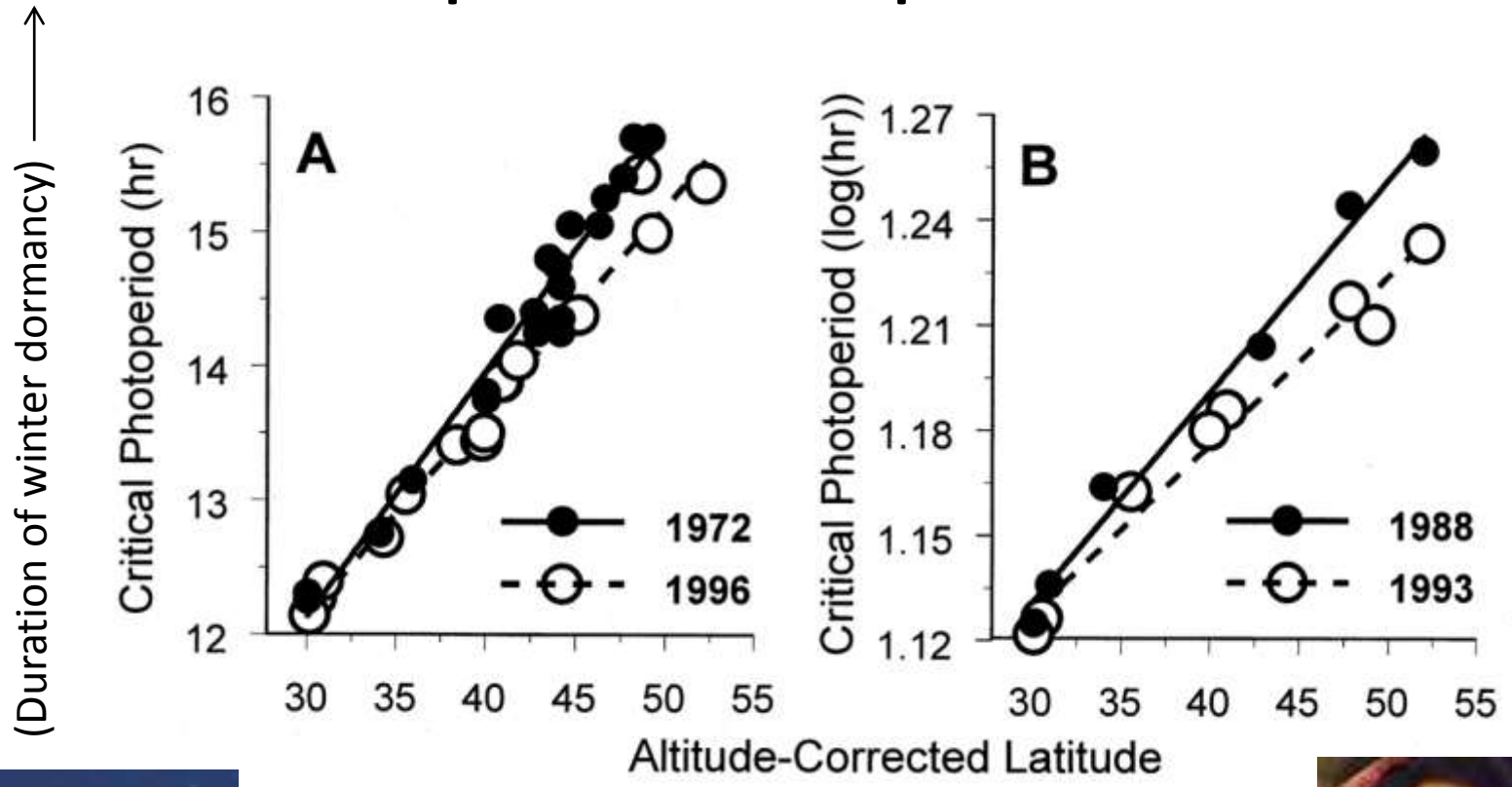
W. smithii: dormancy

- **Critical photoperiod**: threshold daylength inducing or breaking diapause
- Tightly correlated with geography



(From *Bradshaw and Lounibos, 1977*)

Rapid evolution of dormancy in pitcher plant mosquitoes



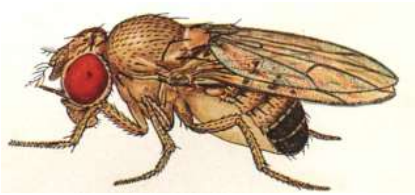
Bradshaw et al., 2001

Dormancy evolves with climate change!

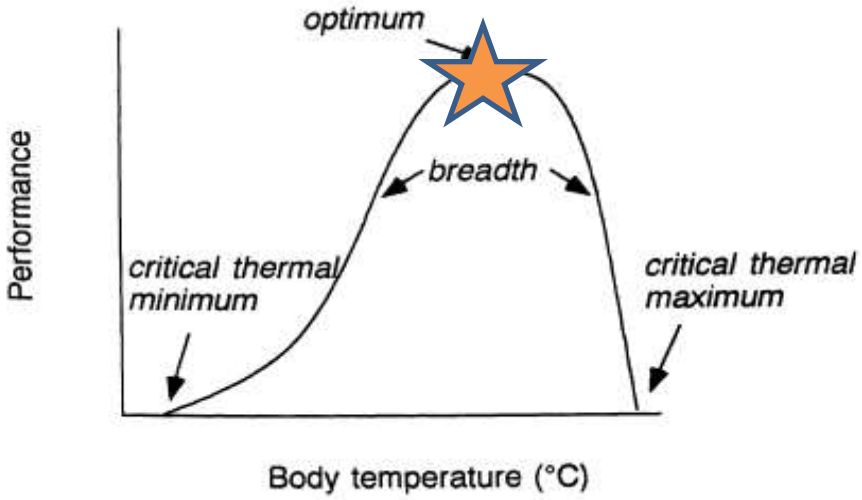
Model organisms allow us study effects of climate change in lab.

What characteristics would be desirable in such an organism?

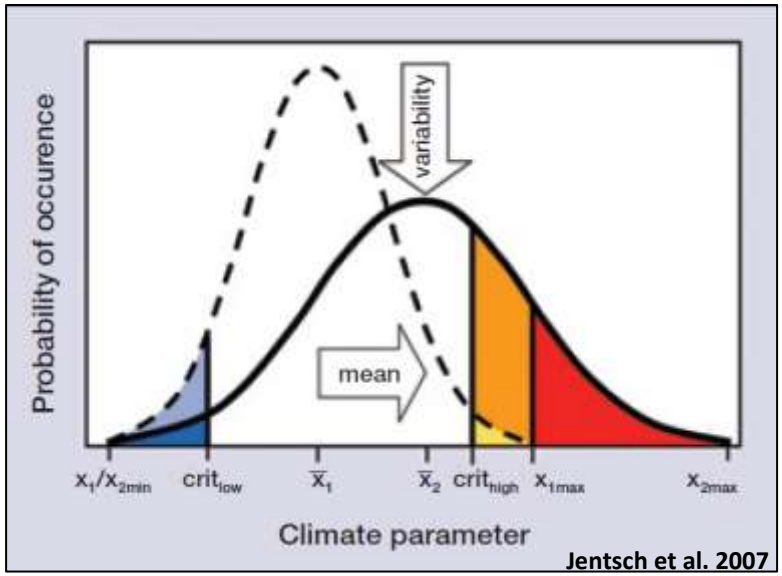
- Short reproduction generation
- Small, fairly easy to raise
- Inexpensive
- Small, previously sequenced, genome



Selection to Variable Temperatures

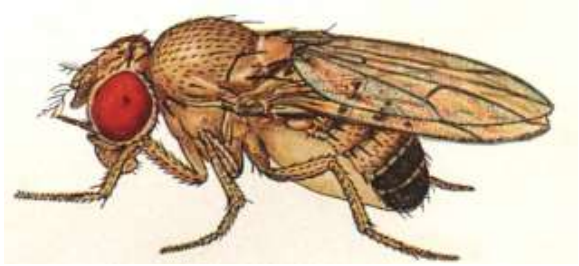


Huey and Kingsolver (1993)

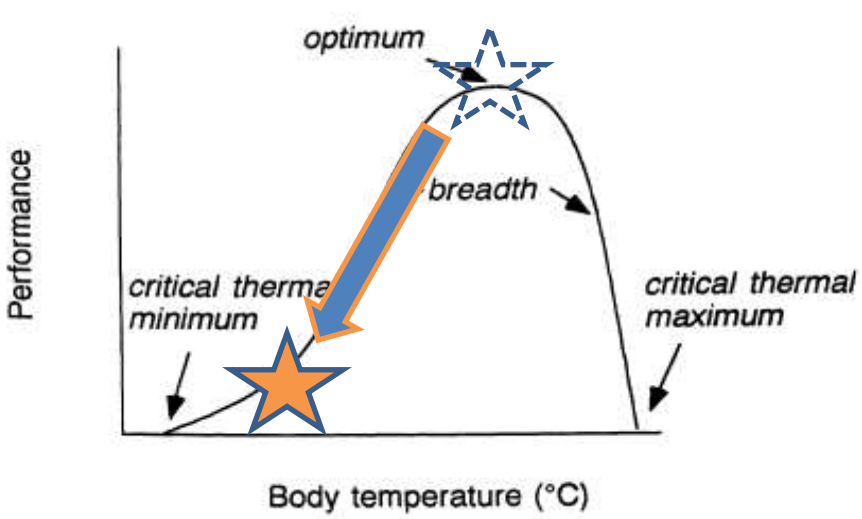


Jentsch et al. 2007

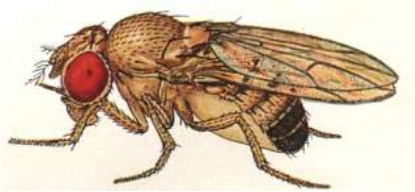
Ethan Siegel



Selection to Variable Temperatures

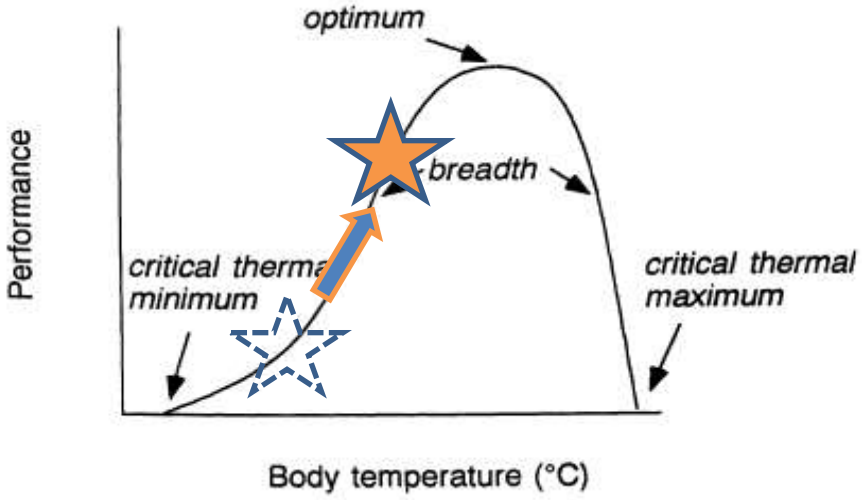


Huey and Kingsolver (1993)

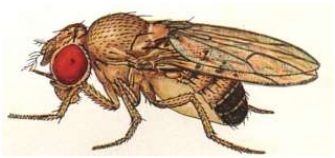


Chill Coma

Selection to Variable Temperatures



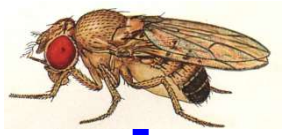
Huey and Kingsolver (1993)



Chill Coma

Chill Coma Recovery

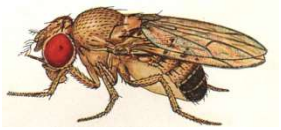
Selection to Variable Temperatures



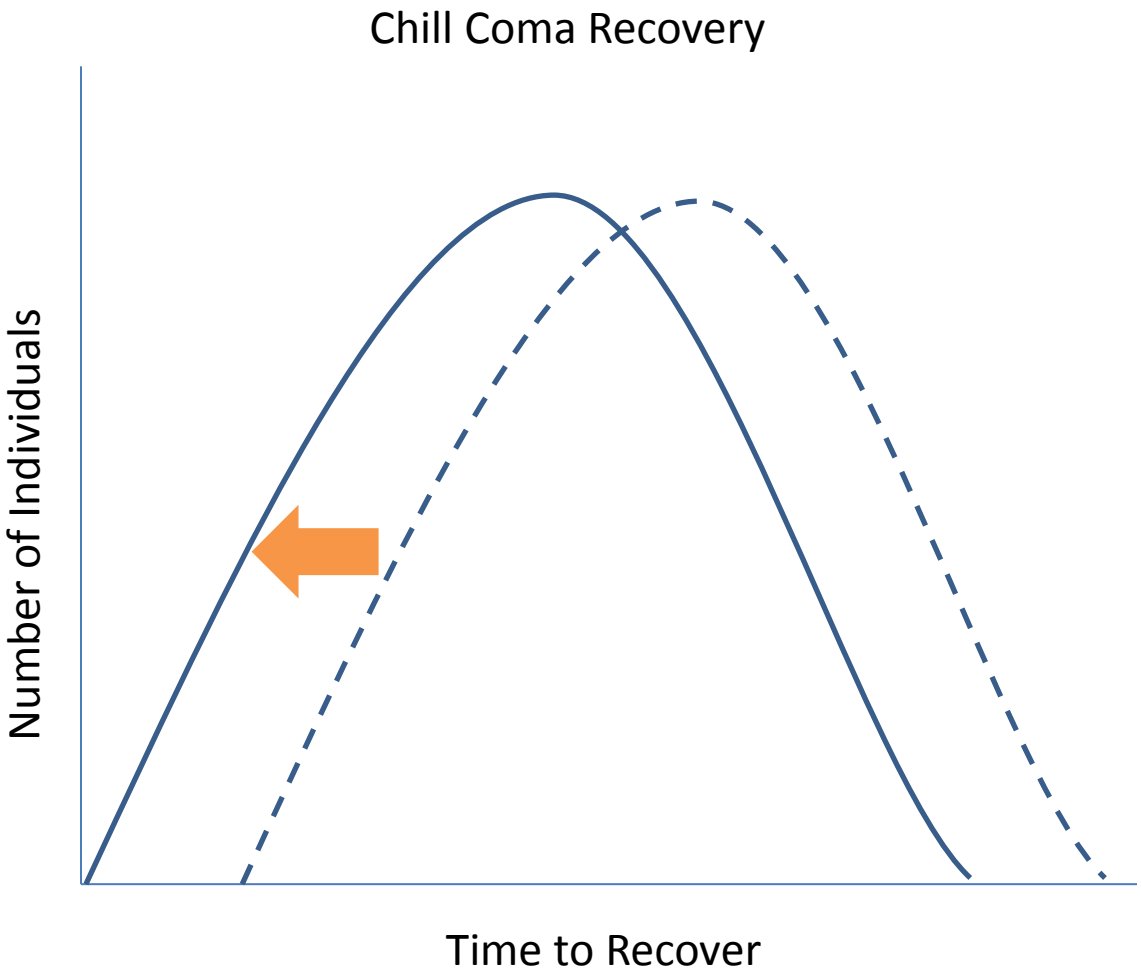
Temperature Drops

Chill Coma

Temperature Returns

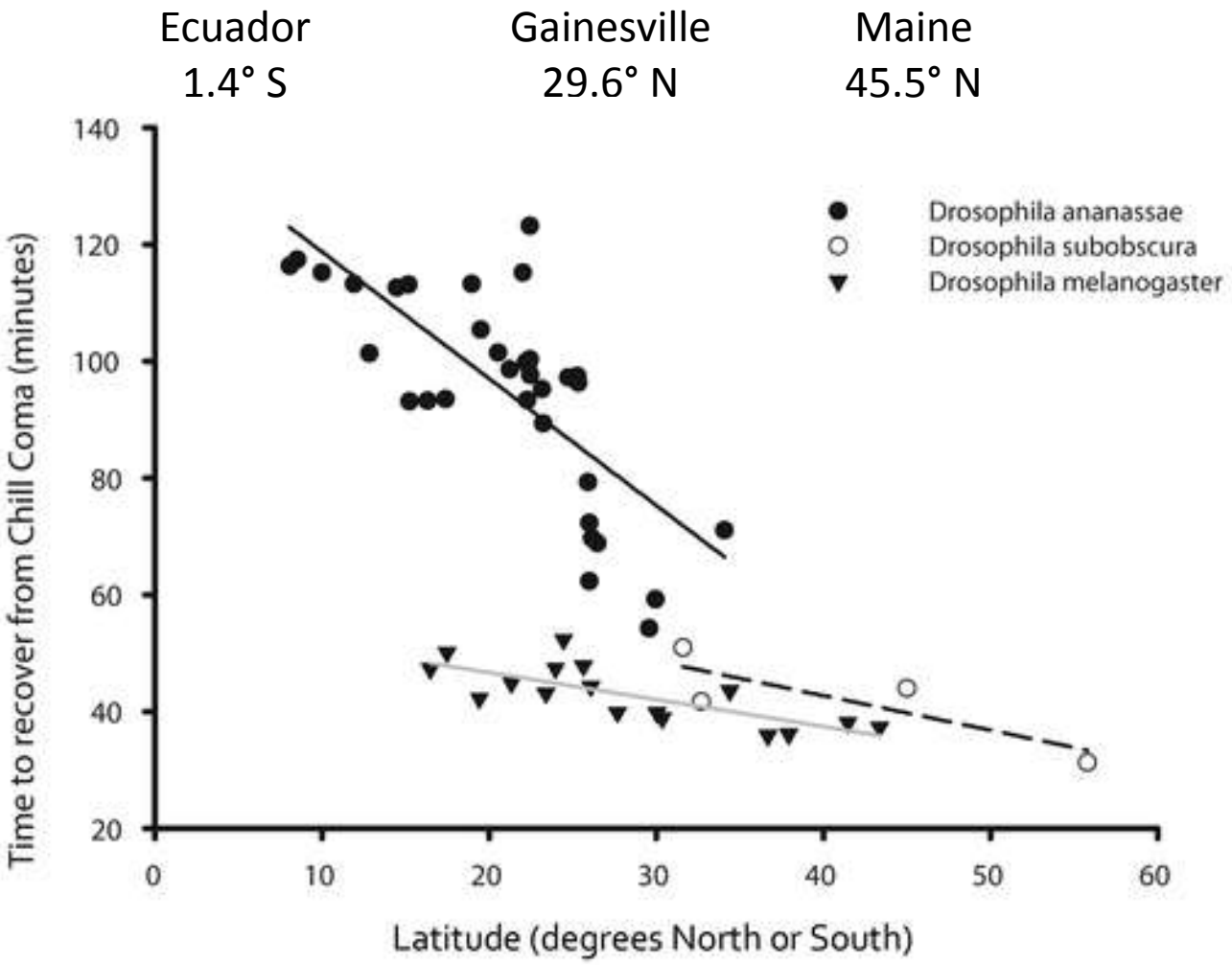


Chill Coma Recovery



Chill Coma Recovery

Chill coma recovery times scaled with latitude in *Drosophila* reared at the same conditions.



Sinclair et al. 2012