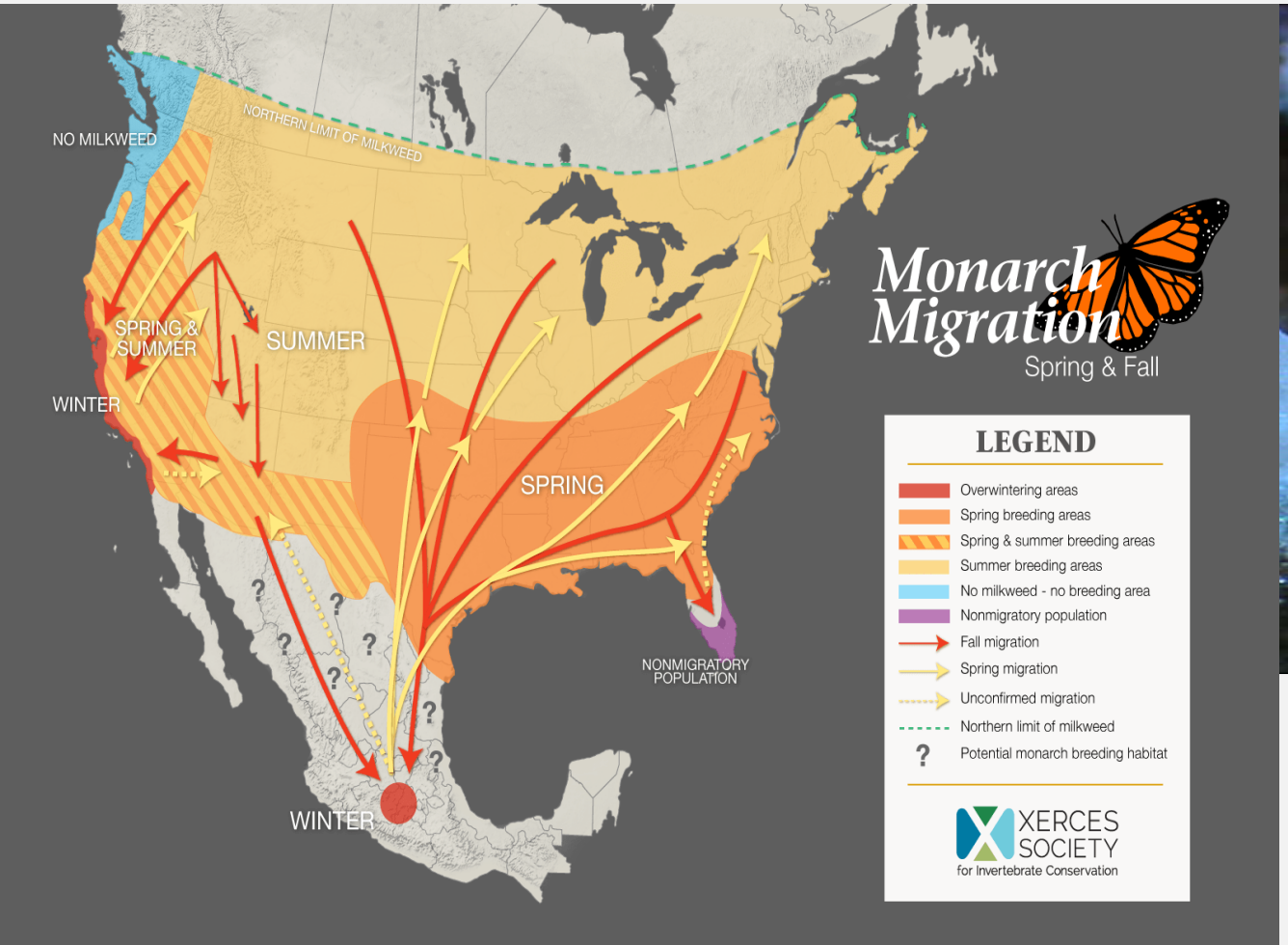
METABOLISM OF THE SPRING FIELD CRICKET *GRYLLUS VELETIS* DURING FREEZING, THAWING AND RECOVERY

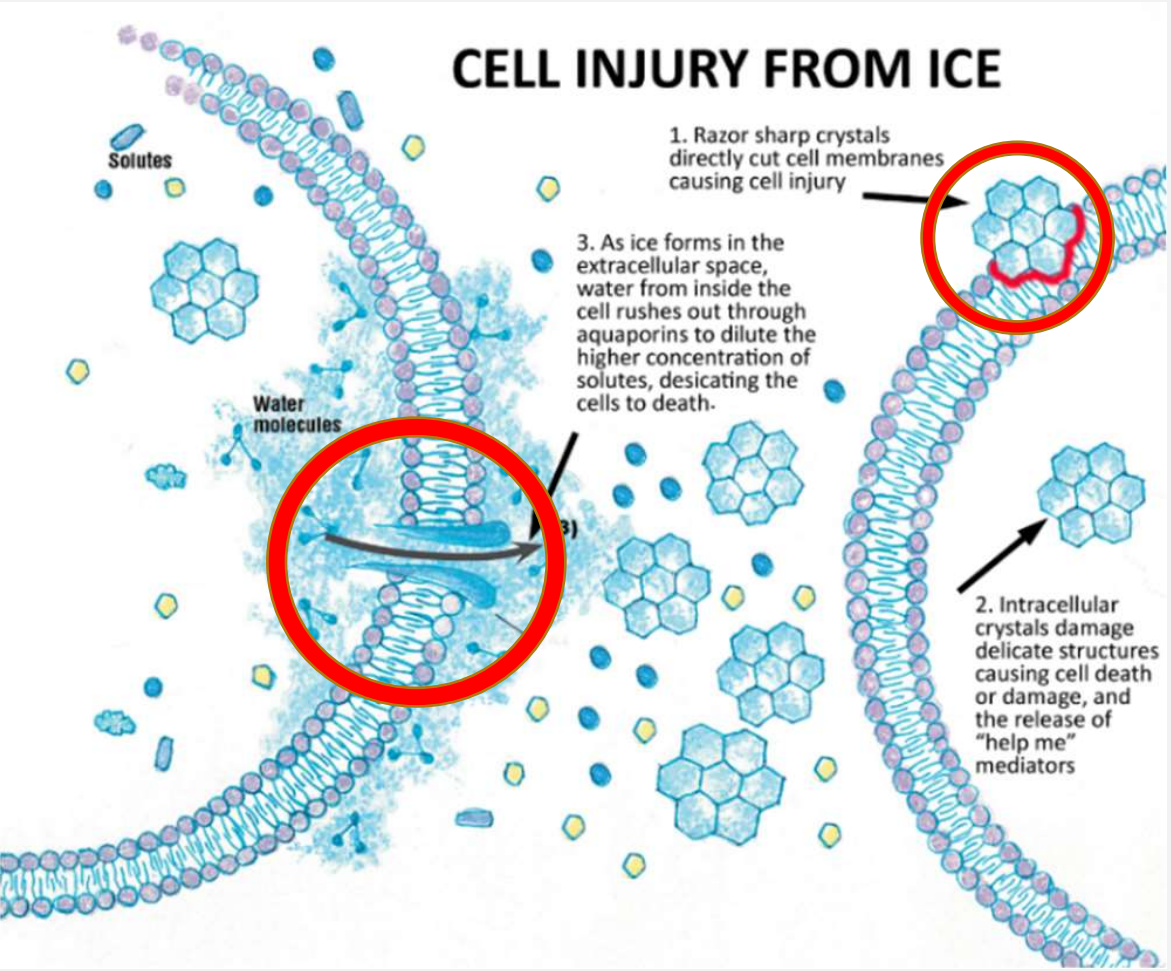
By Julian Moulton

INSECTS IN WINTER



Freeze Tolerant: An organism that can survive a proportion of their body water freezing

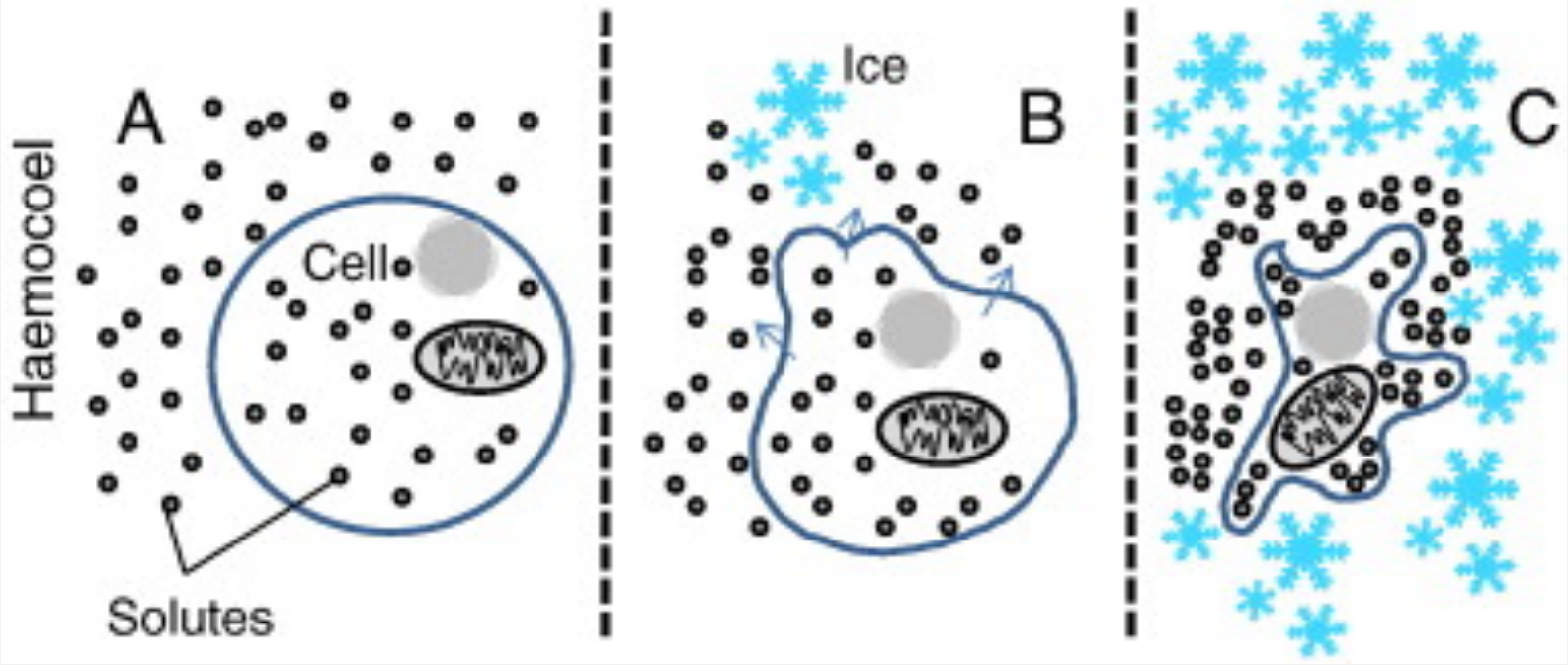
DANGERS OF LOW TEMPERATURES AND FREEZING



Five main harmful effects of freezing

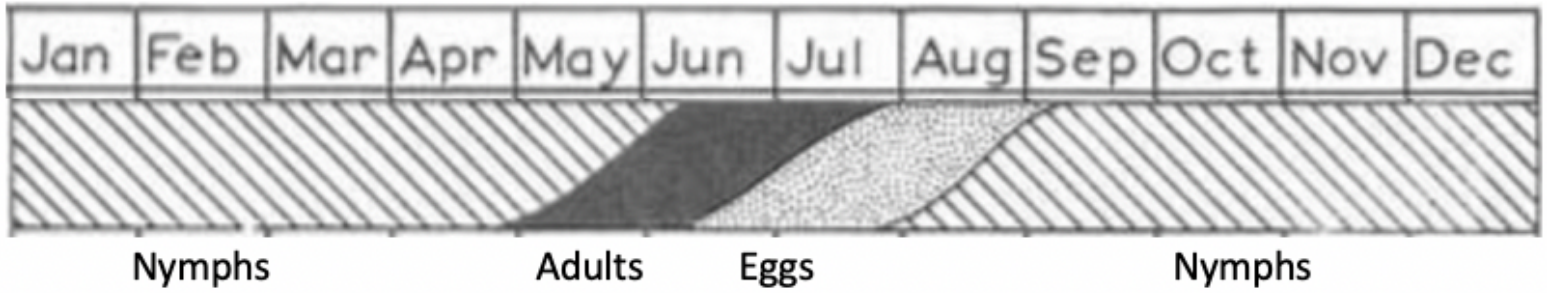
- Effecting the structure of macromolecules
- Inability to accrue essential nutrients
- Buildup of harmful cations or metabolic byproducts
- Intracellular Ice formation
- Cellular dehydration

FREEZE TOLERANCE MECHANISMS

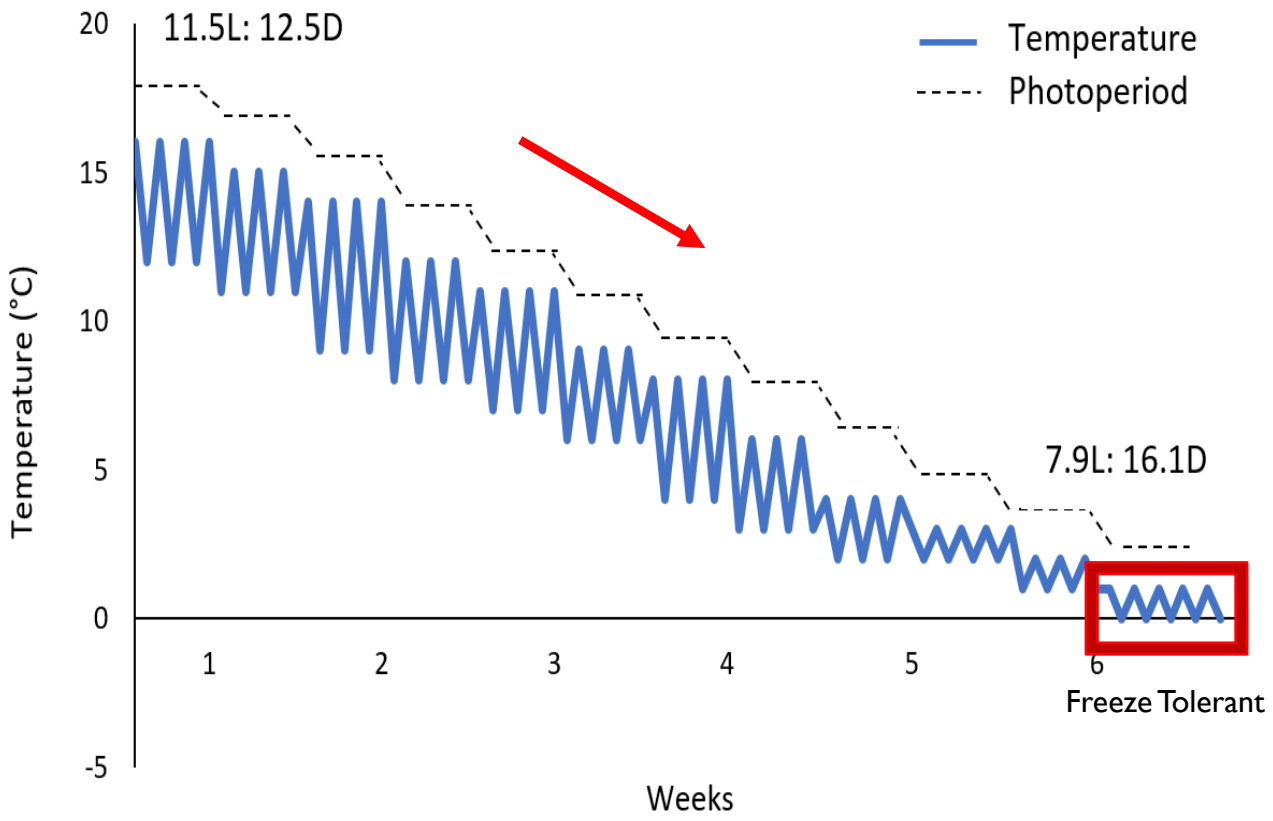


- Control of ice propagation
- Accumulating cryoprotectants
- Metabolic suppression

SPRING FIELD CRICKET



SPRING FIELD CRICKET



1. What causes the burst of CO_2 observed at the onset of freezing?

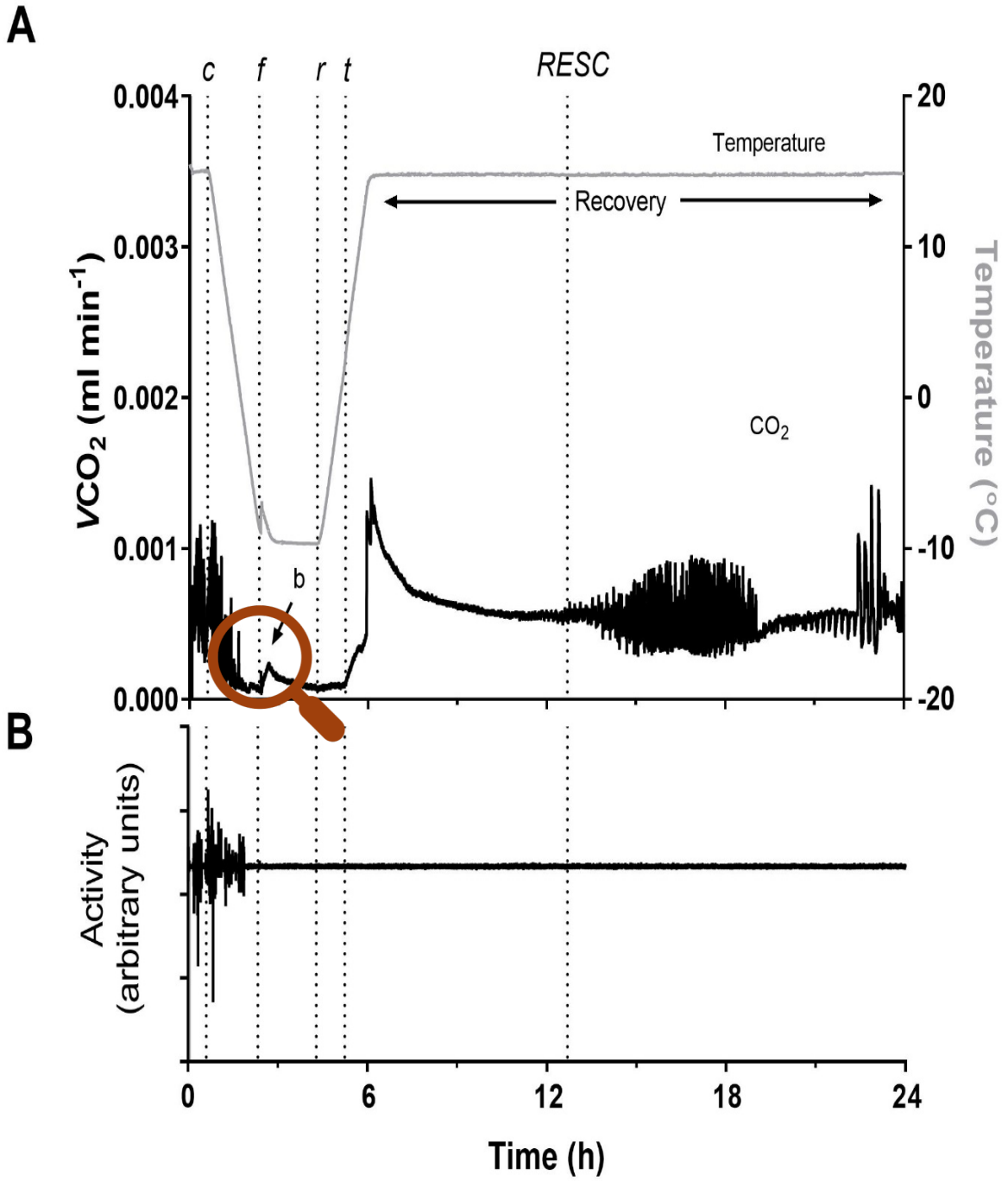
2. What are the short term and long term metabolic costs of freezing?

HYPOTHESES

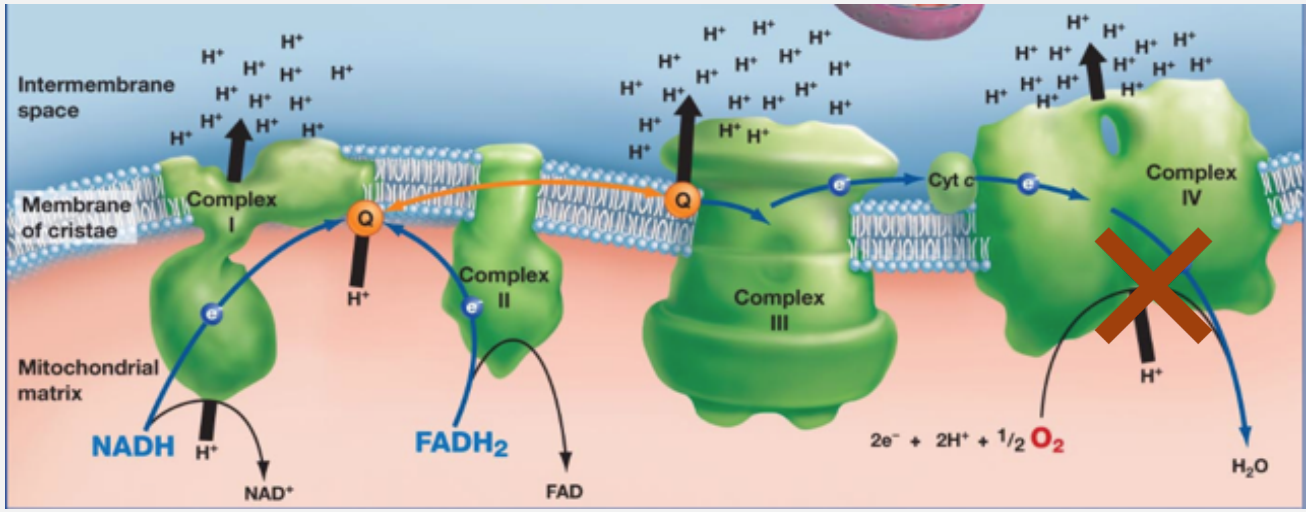
1. A change in the CO_2 buffering capacity of hemolymph, rather than an increase in metabolism, drives the burst of CO_2 release from *G. veletis* at the onset of freezing.

2. Recovery from freezing has a significant metabolic cost, so crickets that froze will have a higher metabolic rate than crickets that were brought down to -8 °C but did not freeze, as well as crickets that were only acclimated but were kept at 15 °C.

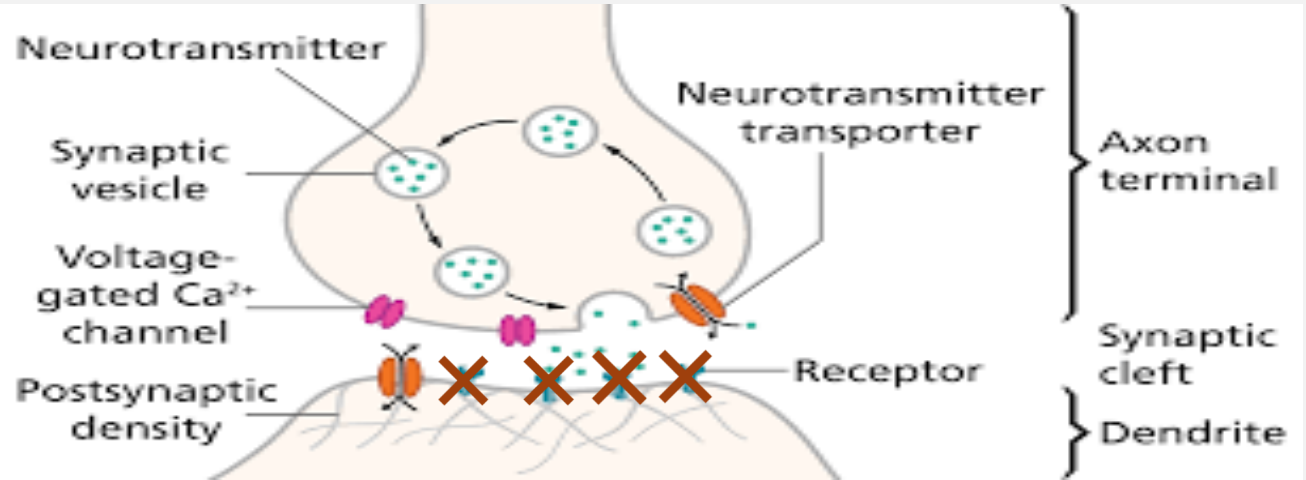
HYPOTHESIS 1



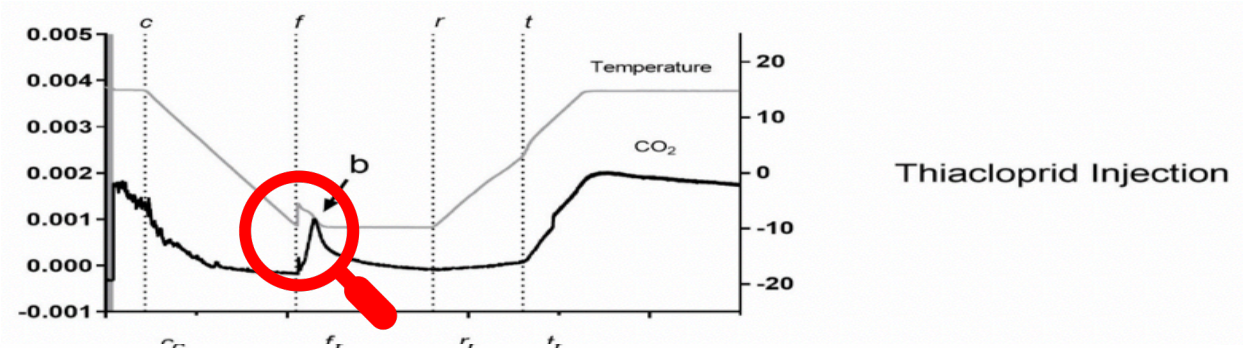
Effects of cyanide



Effects of Thiacloprid

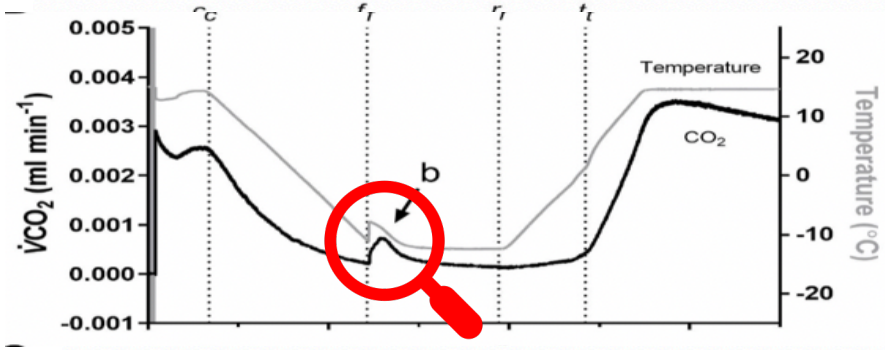


HYPOTHESIS 1



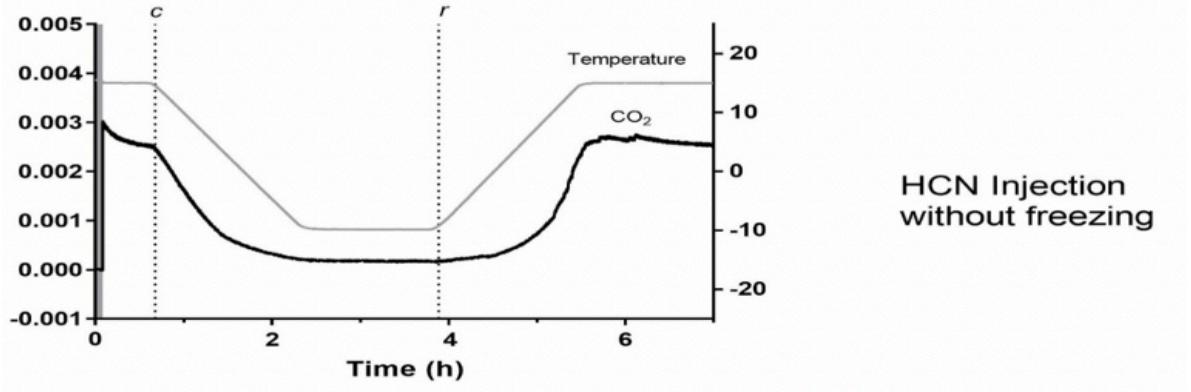
Thiacloprid Injection

Nervous system response **X**



HCN Injection

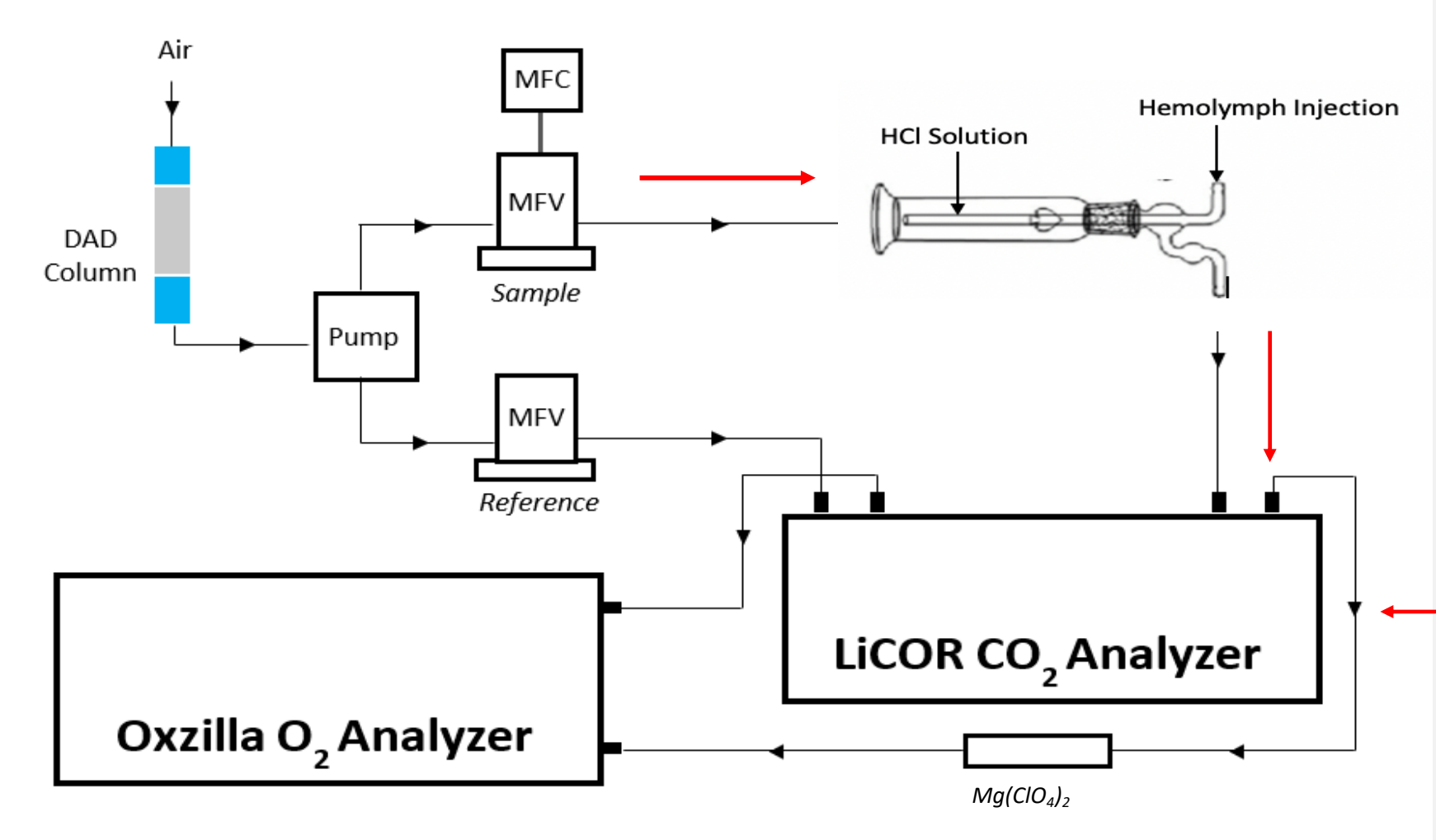
Metabolic response **X**



HCN Injection without freezing

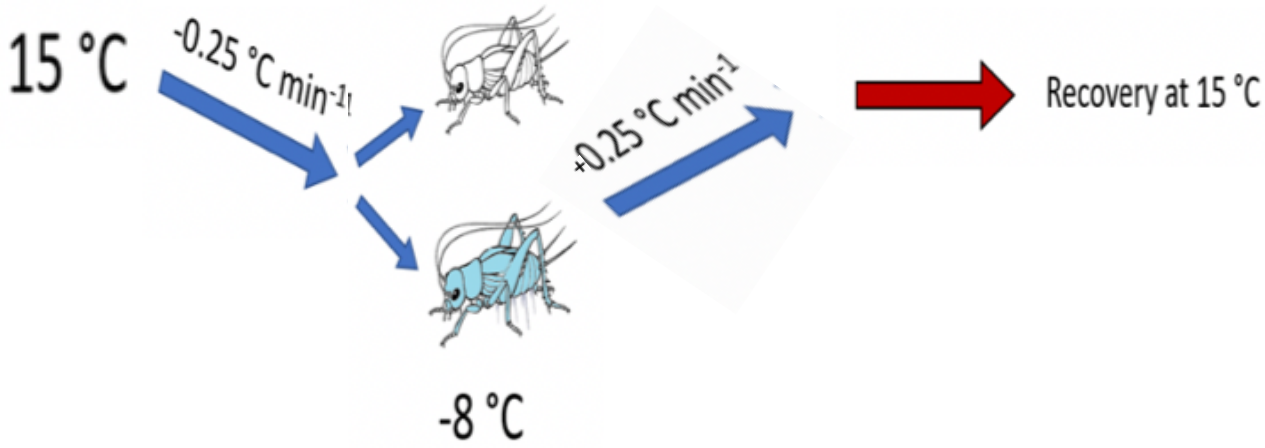
Injection response **X**

FLOW THROUGH RESPIROMETRY



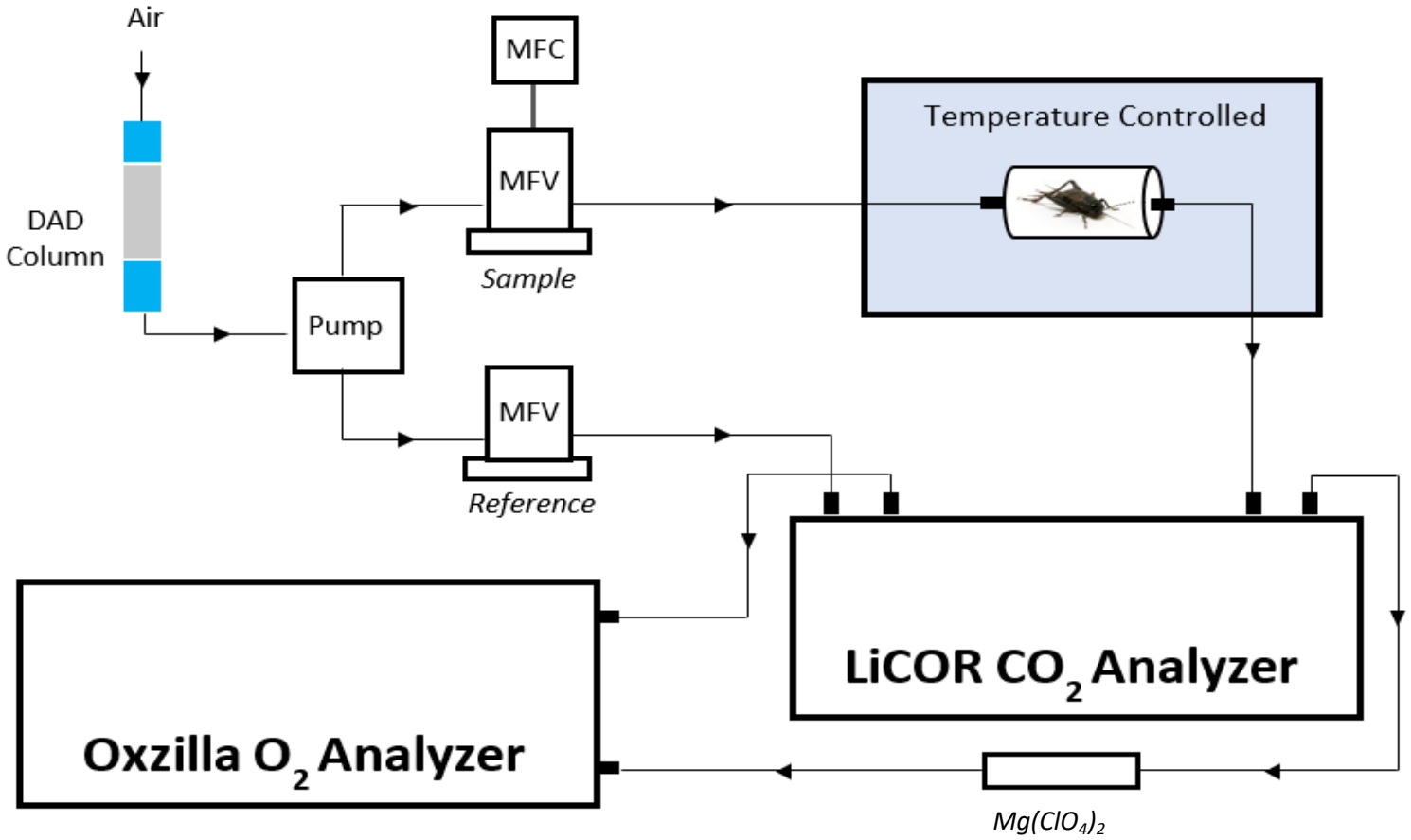
Measures CO_2 produced

HYPOTHESIS 2



Bringing the crickets down to -8 °C meant about half of the crickets froze and half did not.

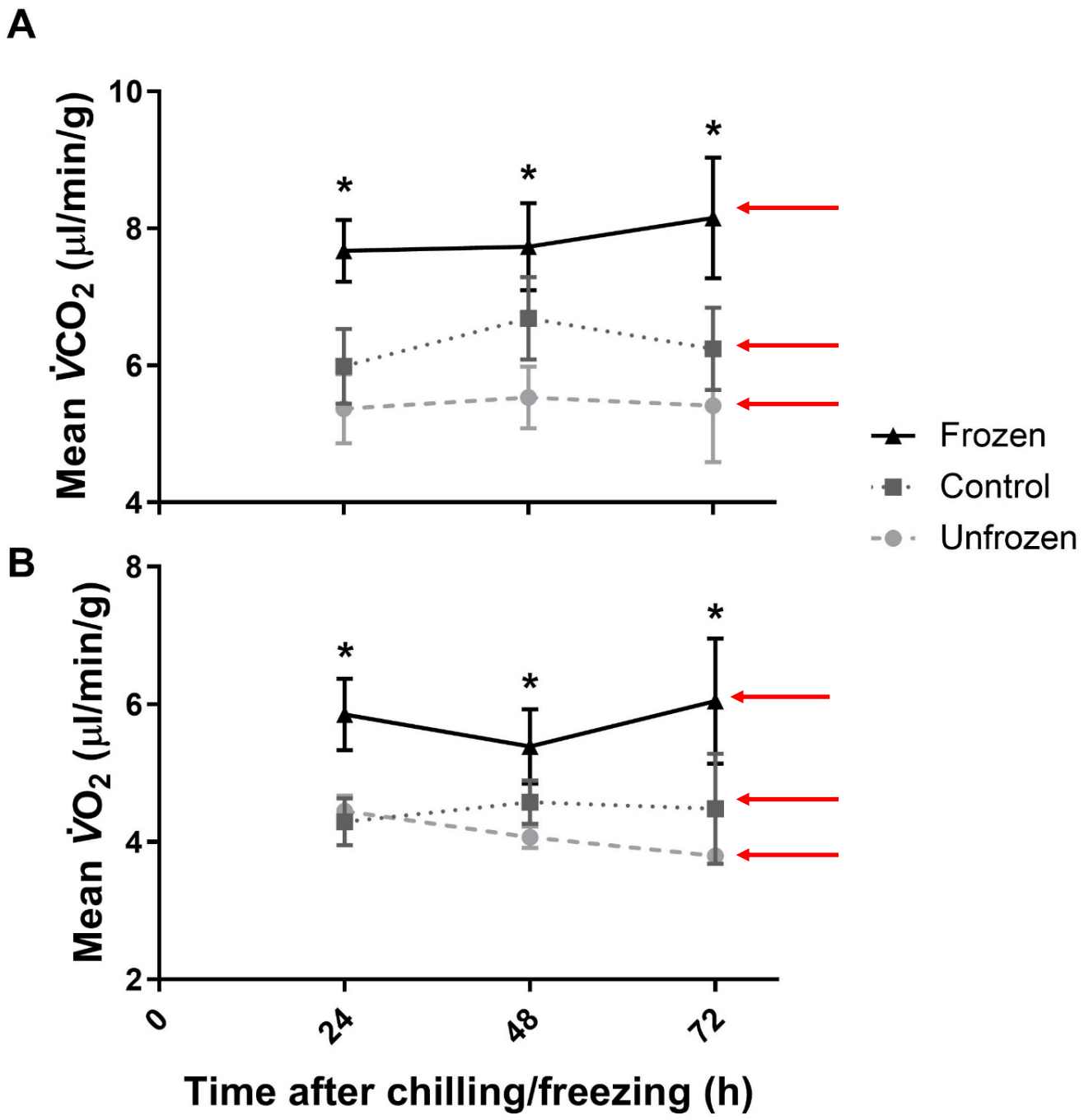
STOP FLOW RESPIROMETRY



- Placed crickets in respirometer 24, 48, and 72 hours after freezing, and again after molting
- Stop flow respirometry allowed us to test multiple crickets at once and magnifies the differences between metabolic rates

SHORT TERM RECOVERY

- There was a significantly higher metabolic rate in crickets that froze compared to the control and unfrozen crickets at 24, 48, and 72 hours after being cooled.
- Chilled crickets in general had higher metabolic rates than control crickets, but the difference was not statistically significant



LONG TERM RECOVERY

- This difference was not seen when metabolic rates were taken after molting
- Frozen crickets molted later than unfrozen crickets, and many struggled to make it through the molt

- 0 out of 12 frozen crickets survived: survival rate 0%
- 7 out of 14 chilled crickets survived: survival rate 50%
- 5 out of 7 control crickets survived: survival rate 71.4%

DISCUSSION

3 Main Findings

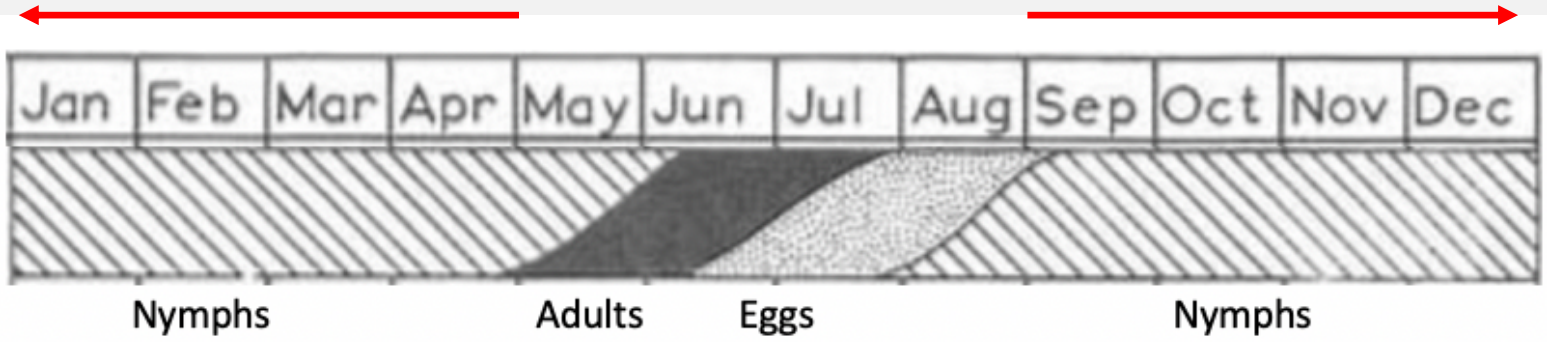
1. The burst of CO_2 observed at the onset of freezing is likely the result of dissolved CO_2 being forced out of hemolymph as it freezes

2. There is a significant metabolic cost associated with freezing and it persists for several days

3. Crickets that froze are less likely to survive until adulthood than crickets that did not freeze

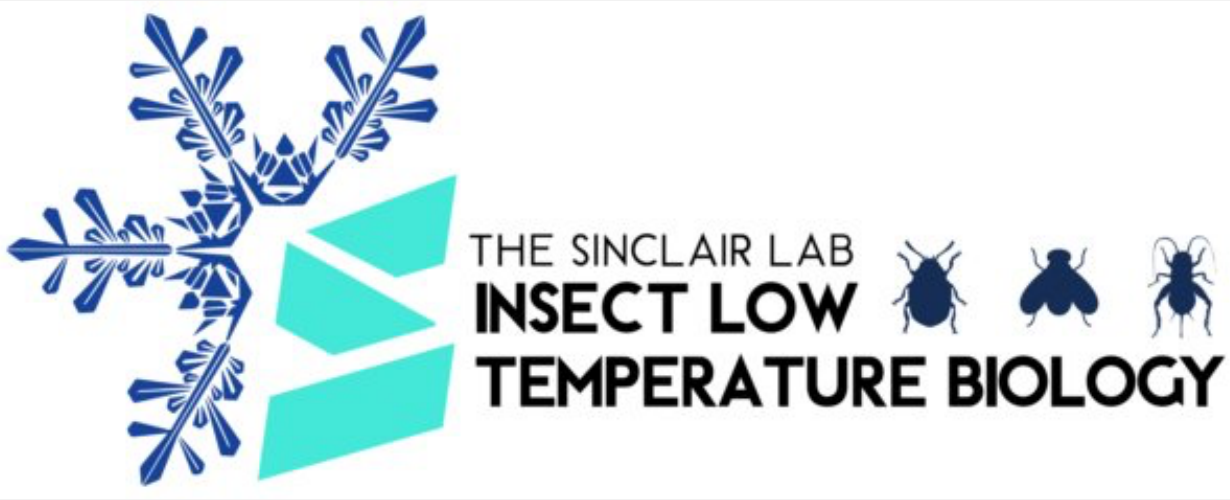
DISCUSSION

Life cycle of Gryllus veletis



- The life cycle of *Gryllus veletis* is dependent on the normal changing of the seasons
- Mechanisms of freeze tolerance need further investigation
- Understanding the cost of freezing could be critical in predicting how freeze tolerant species will be affected by climate change

ACKNOWLEDGEMENTS



Any questions can be sent to julian.moulton@coloradocollege.edu