METABOLISM OF THE SPRING FIELD CRICKET *Gryllus veletis* DURING FREEZING, THAWING AND RECOVERY

By Julian Moulton
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
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

Nervous system response X

Metabolic response X

Injection response X
FLOW THROUGH RESPIROMETRY

Mg(ClO$_4$)$_2$ 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
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