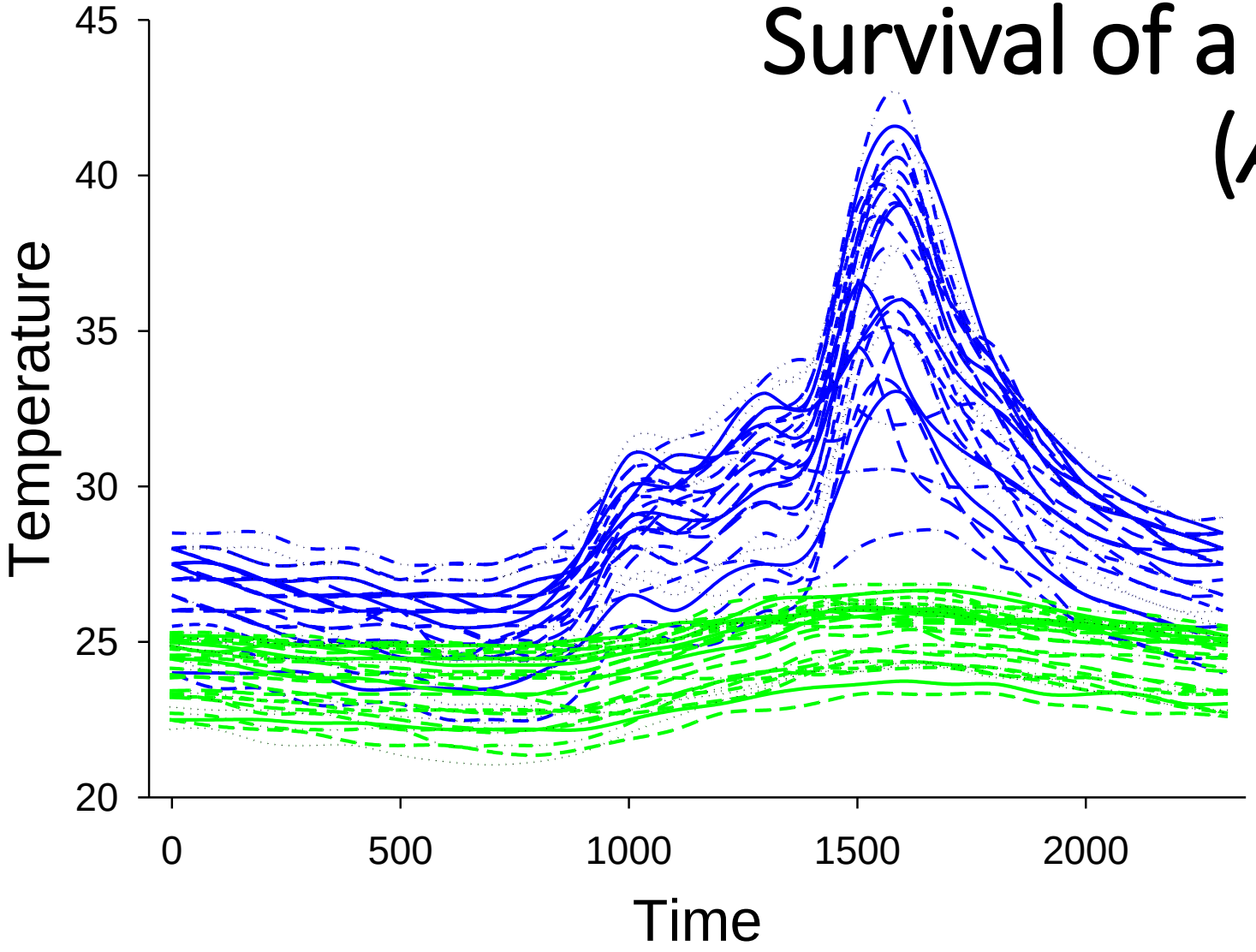
Thermal Spikes Caused by the Urban Heat Island Effect Result in Differential Egg Survival of a Non-native Lizard (*Anolis cristatellus*)



Joshua M Hall

Daniel A Warner

WARNER LABORATORY
PHYSIOLOGY BEHAVIOR EVOLUTION ECOLOGY

AUBURN UNIVERSITY

Urbanization is Global

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- Human population estimated to reach 9 billion by 2050
- Urban land area is expanding twice as fast as population
- Urban habitats create novel, conditions, i.e. Urban Heat Island Effect

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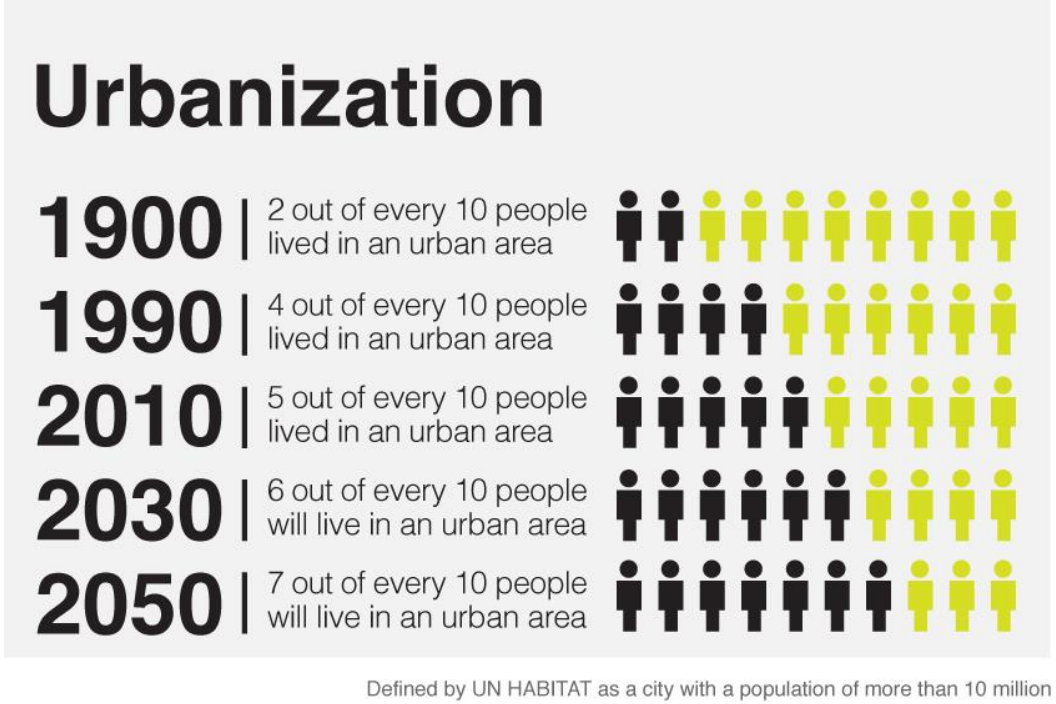
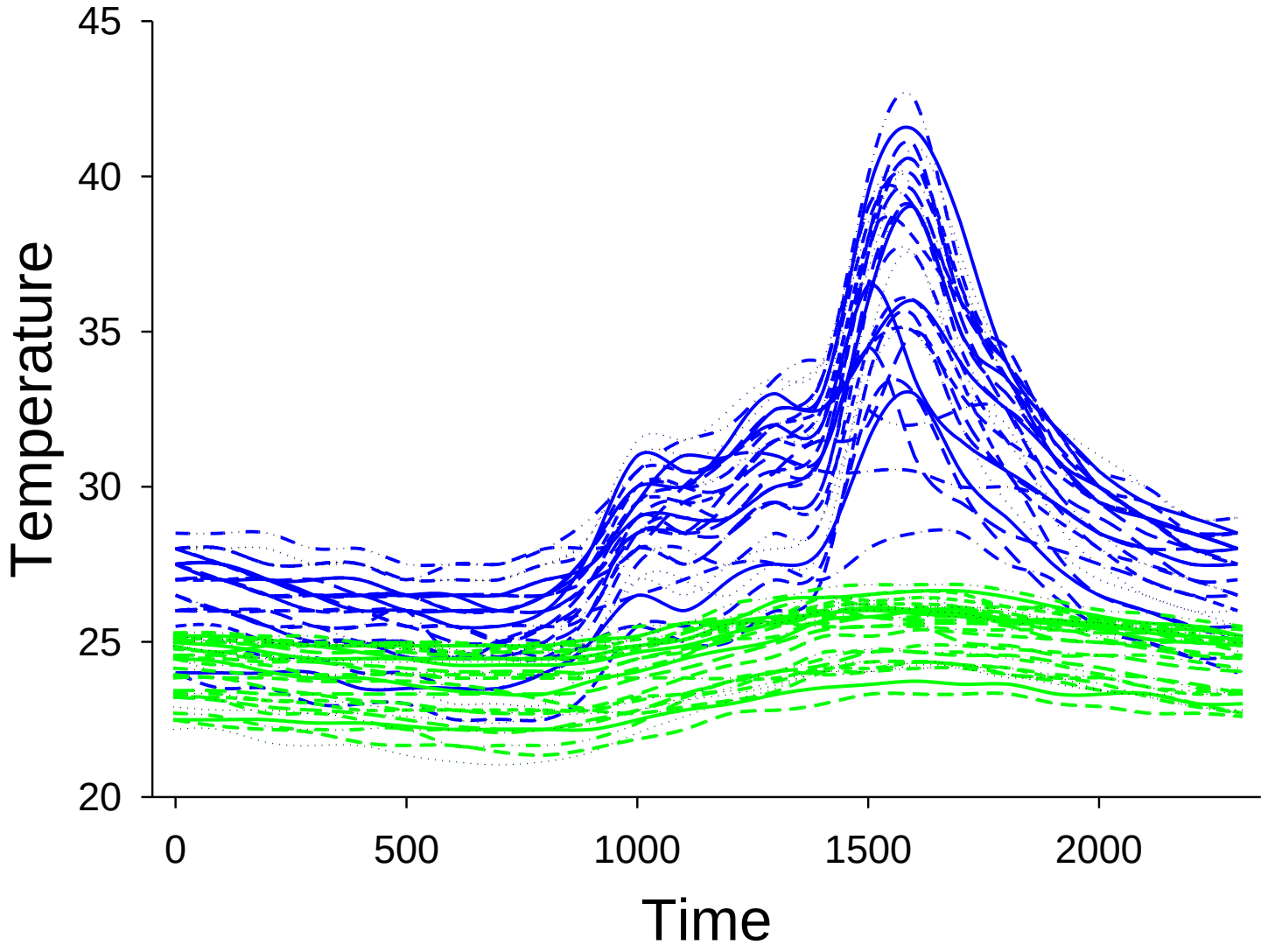


Urban Heat Island Effect



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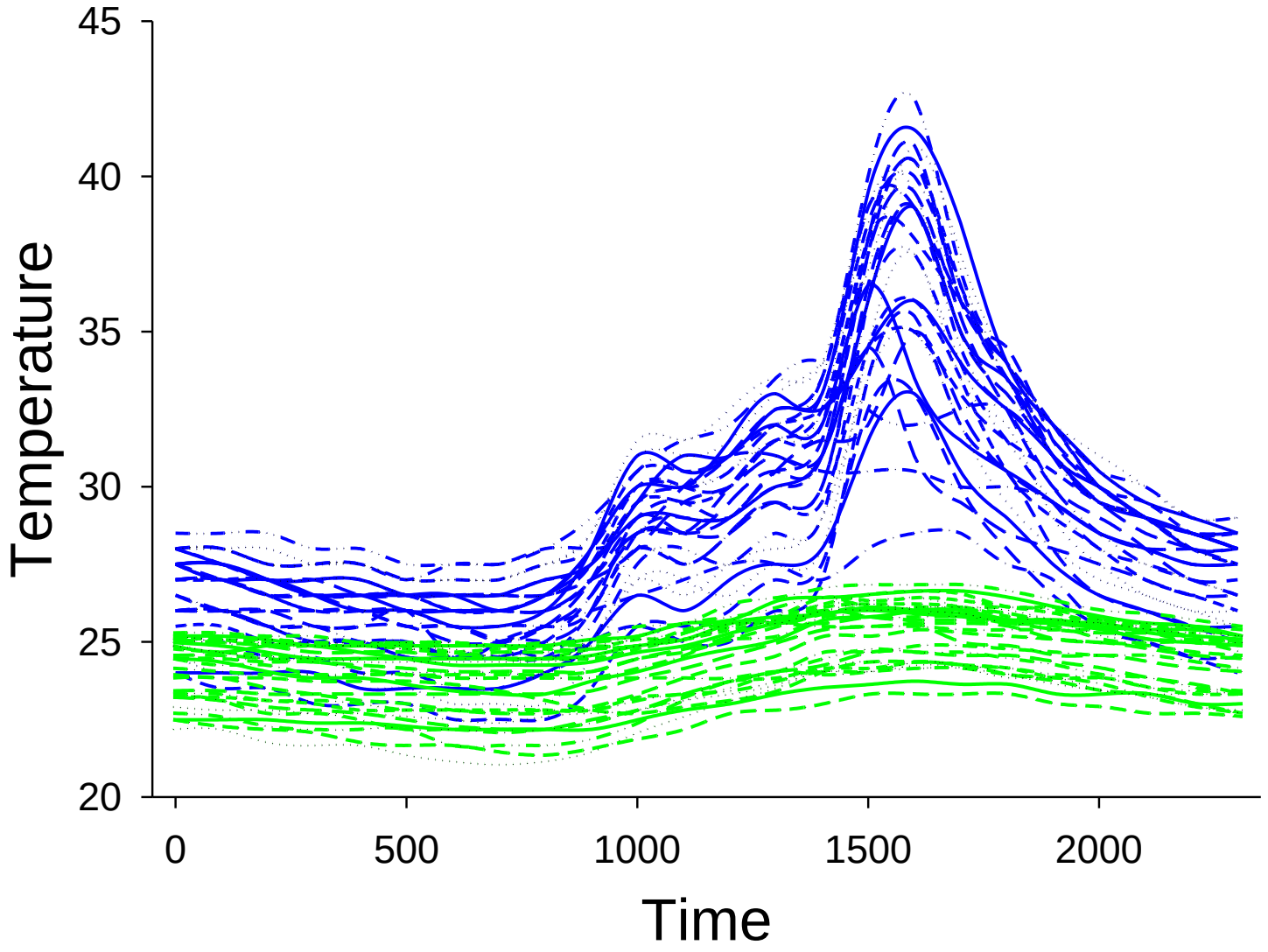
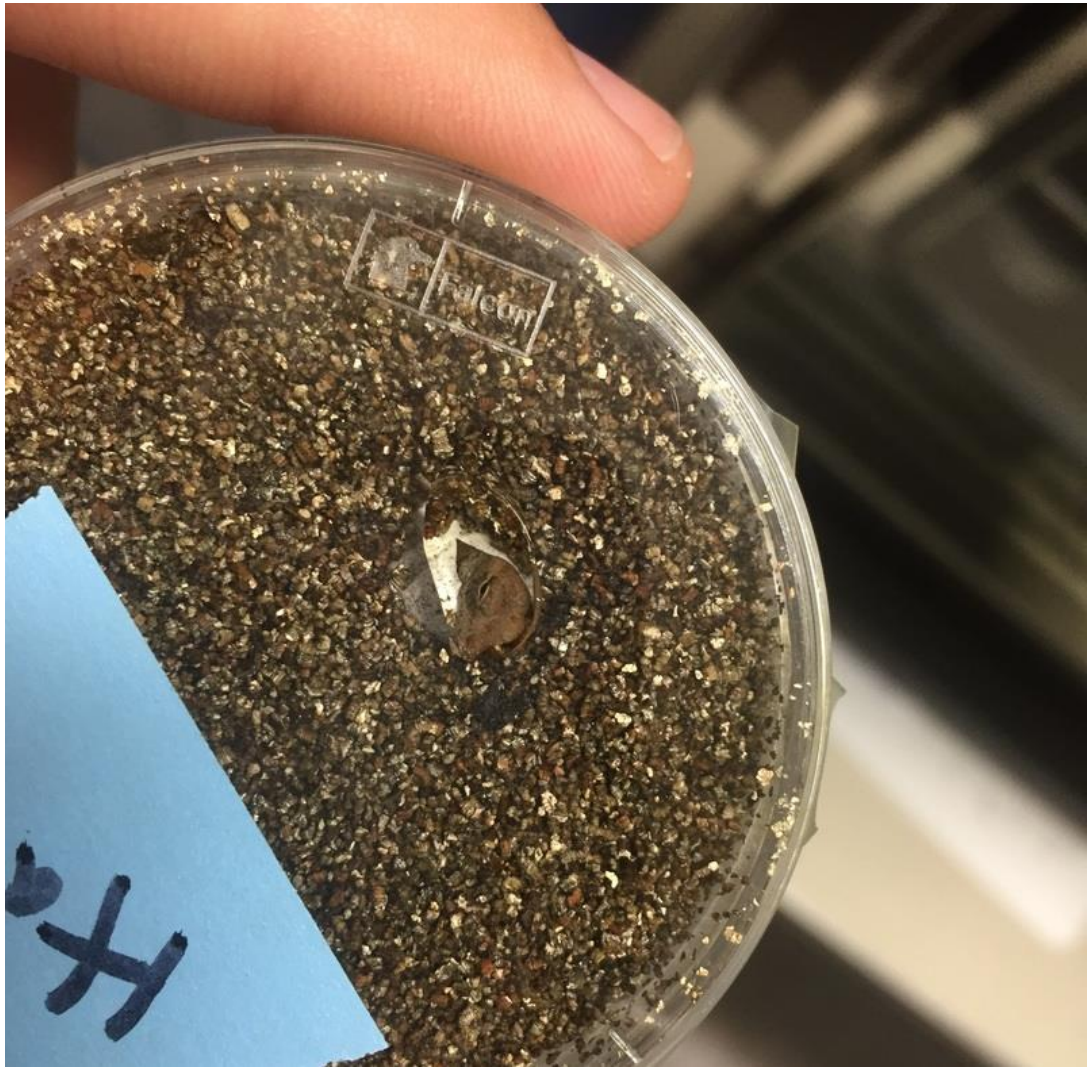


- Average temperatures higher in urban areas than natural sites
- Thermal fluctuations, thermal spikes, more extreme in urban areas
- Implications for ectotherms
  - Adults
  - Developing embryos?

Embryos Respond to Environment

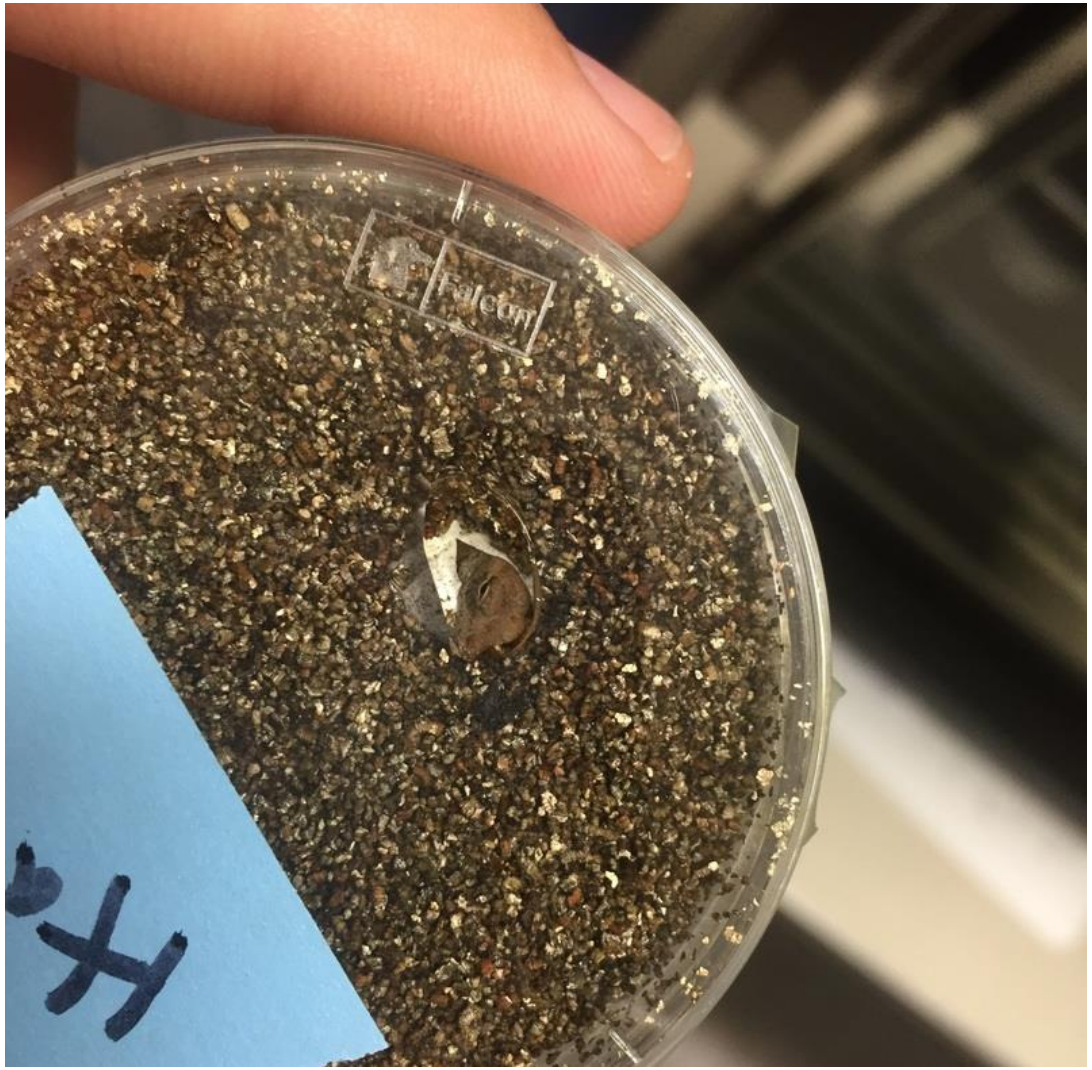


Du W & Shine R. 2015. Biological Reviews. 90: 19-30

Embryos Respond to Environment

- Adjust physiology
  - Alter metabolism
  - Acclimate

- Influence exposure
  - Hatch early
  - Initiate diapause



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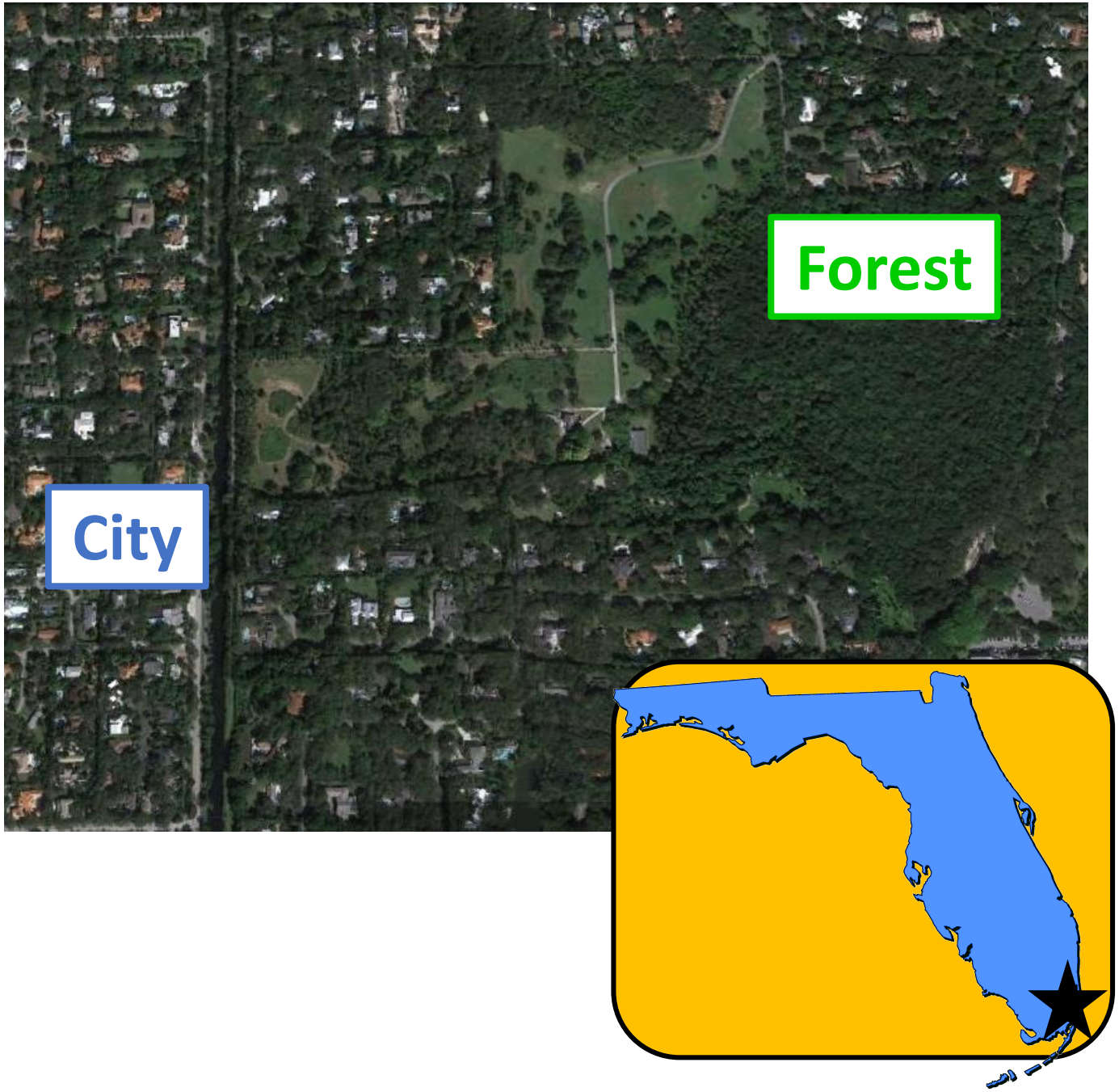

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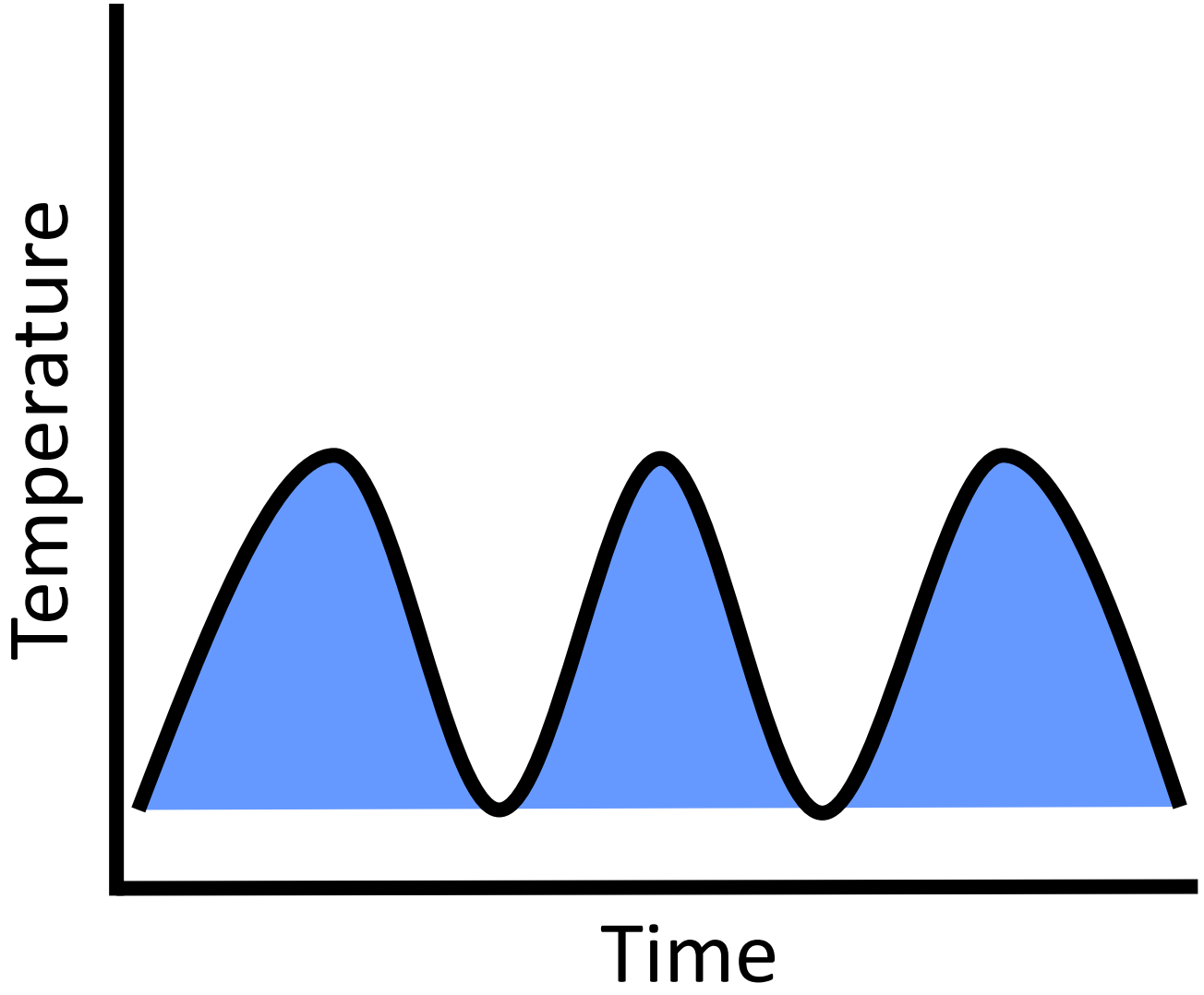

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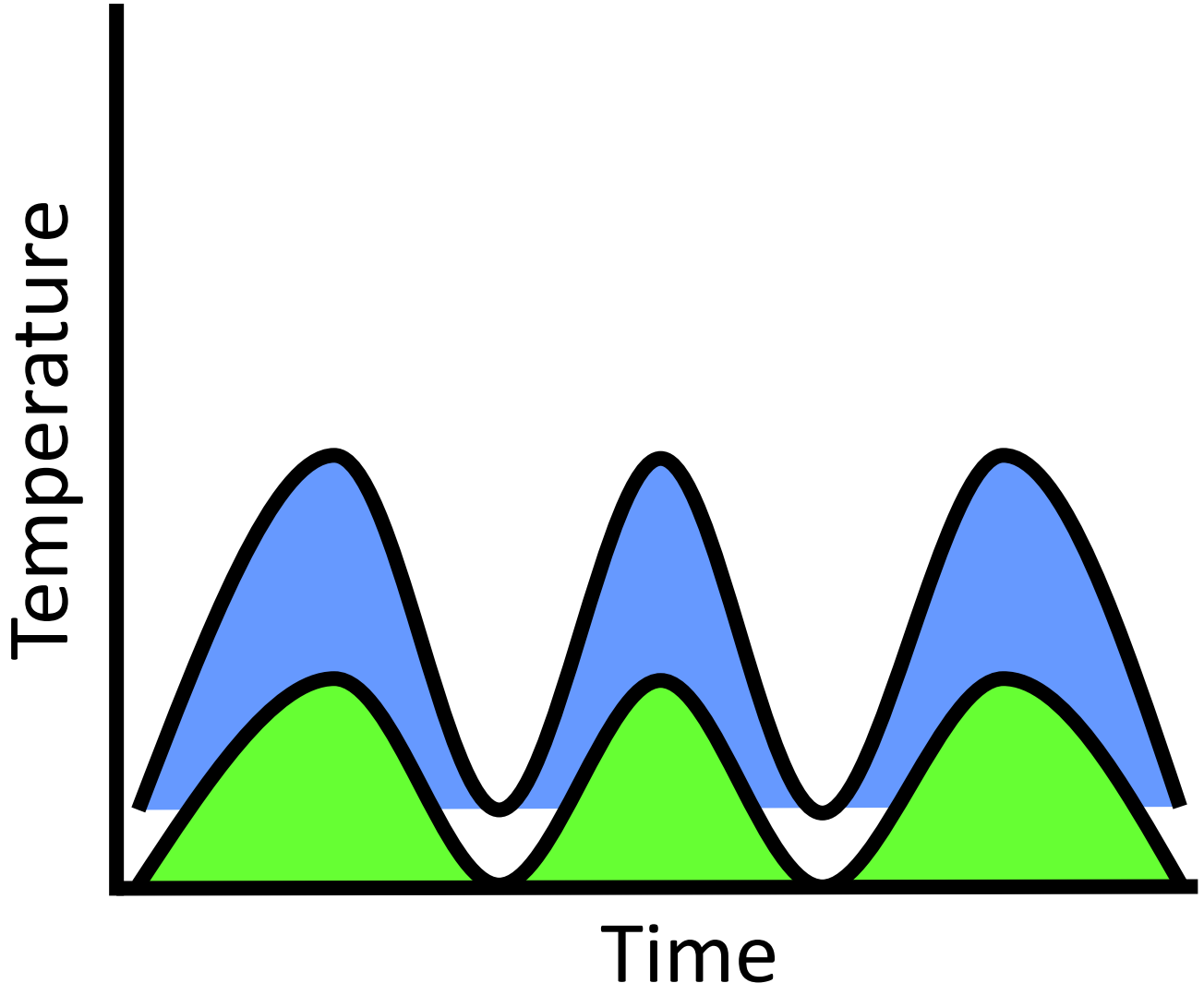

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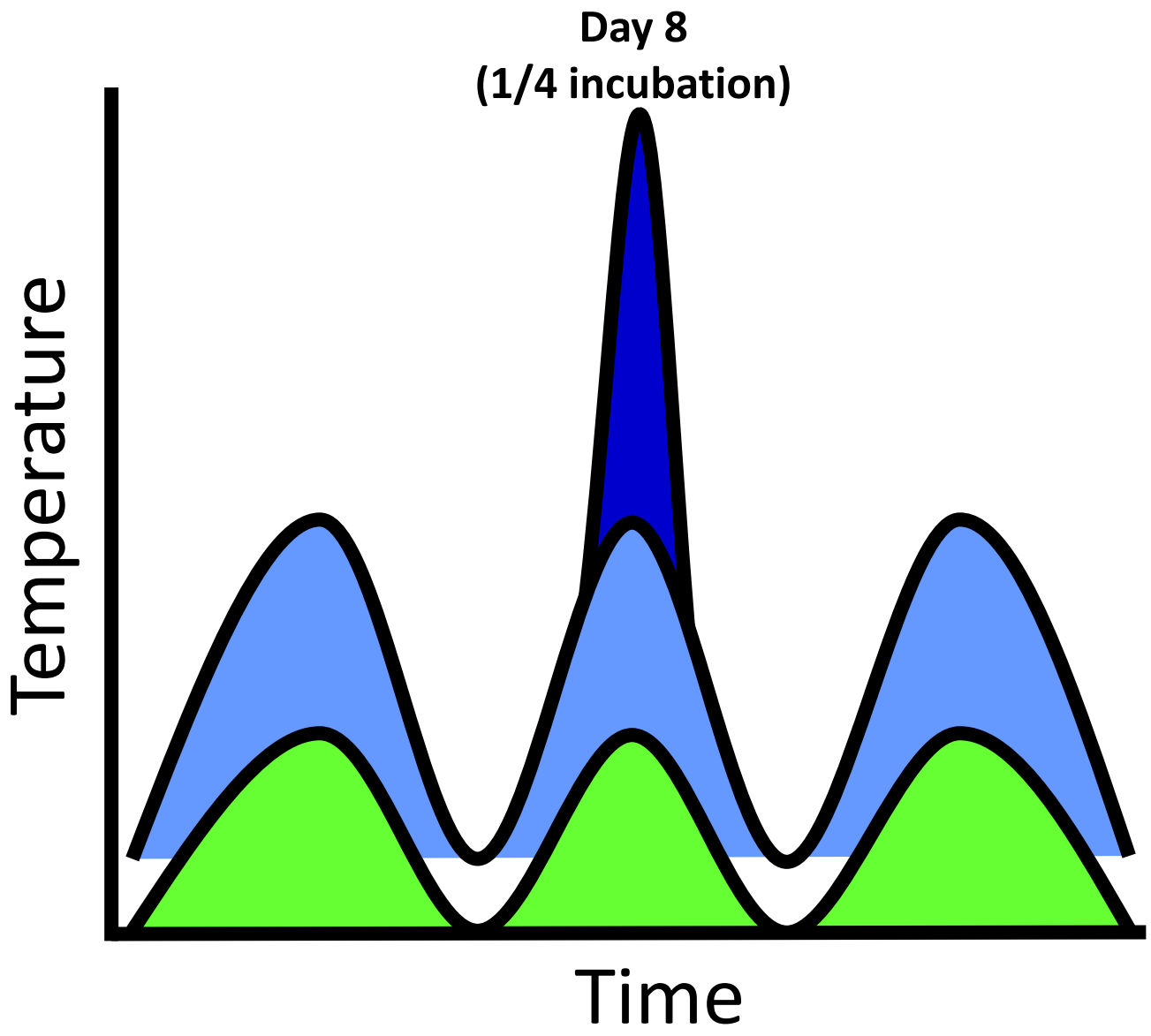

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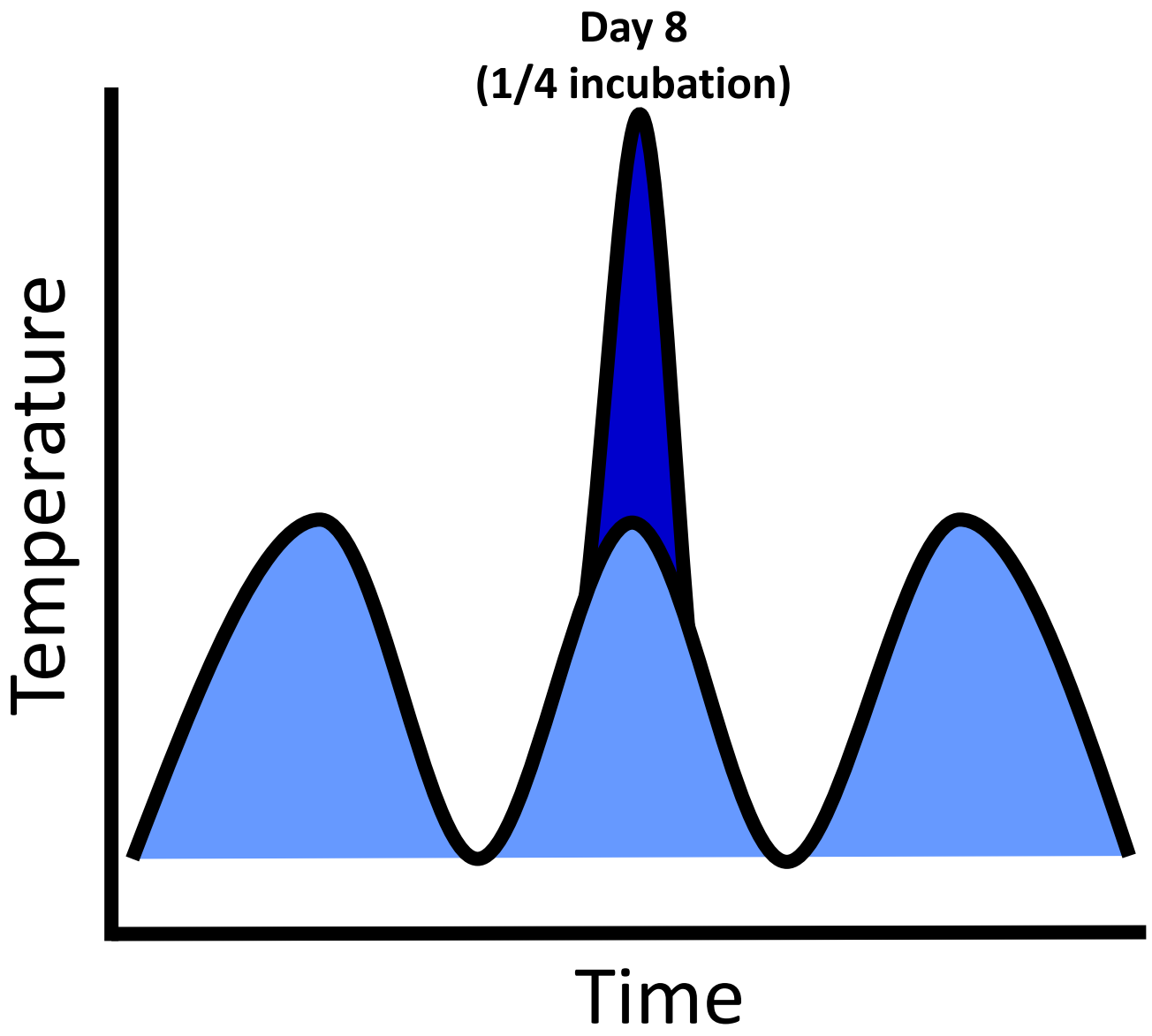

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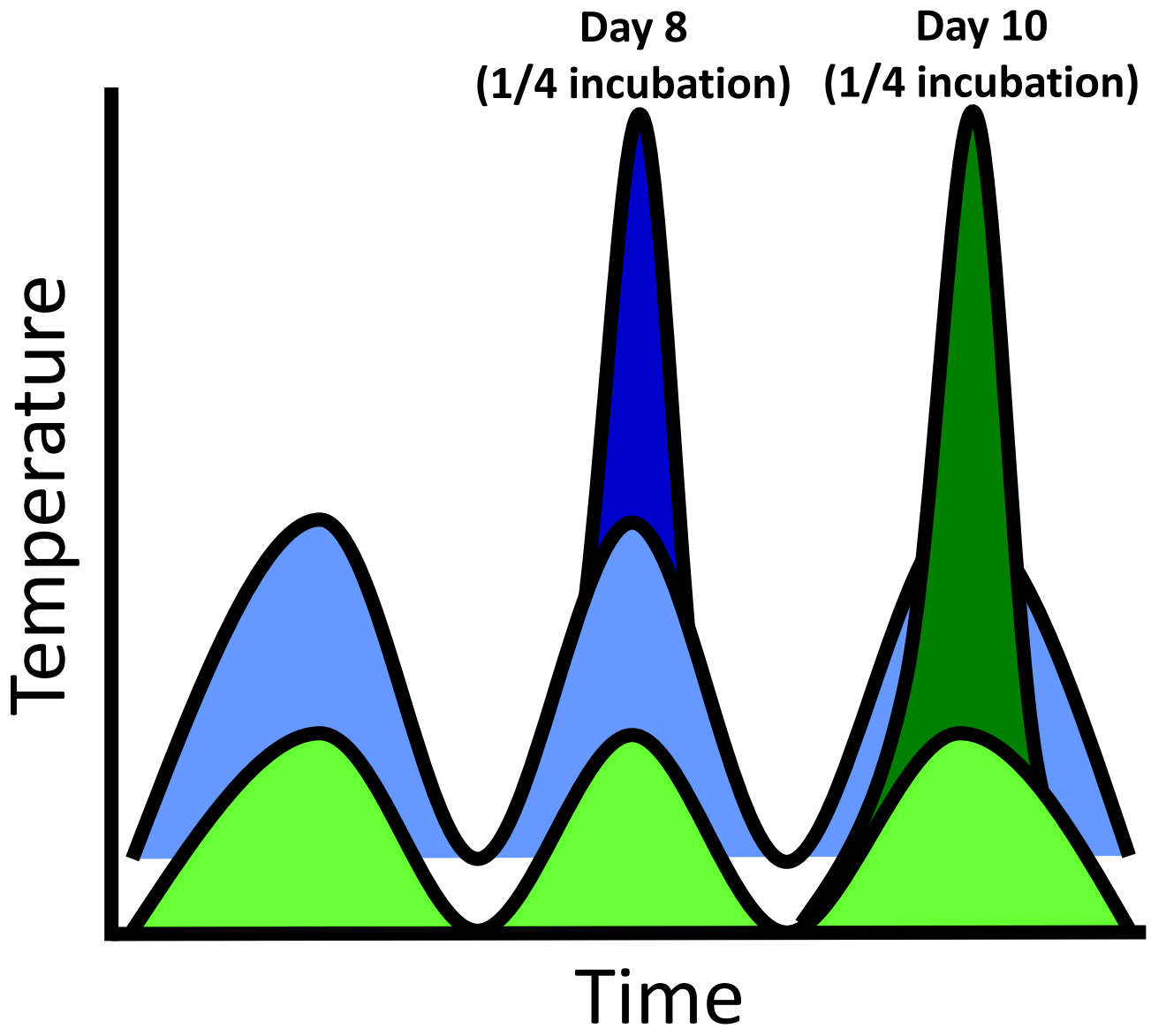

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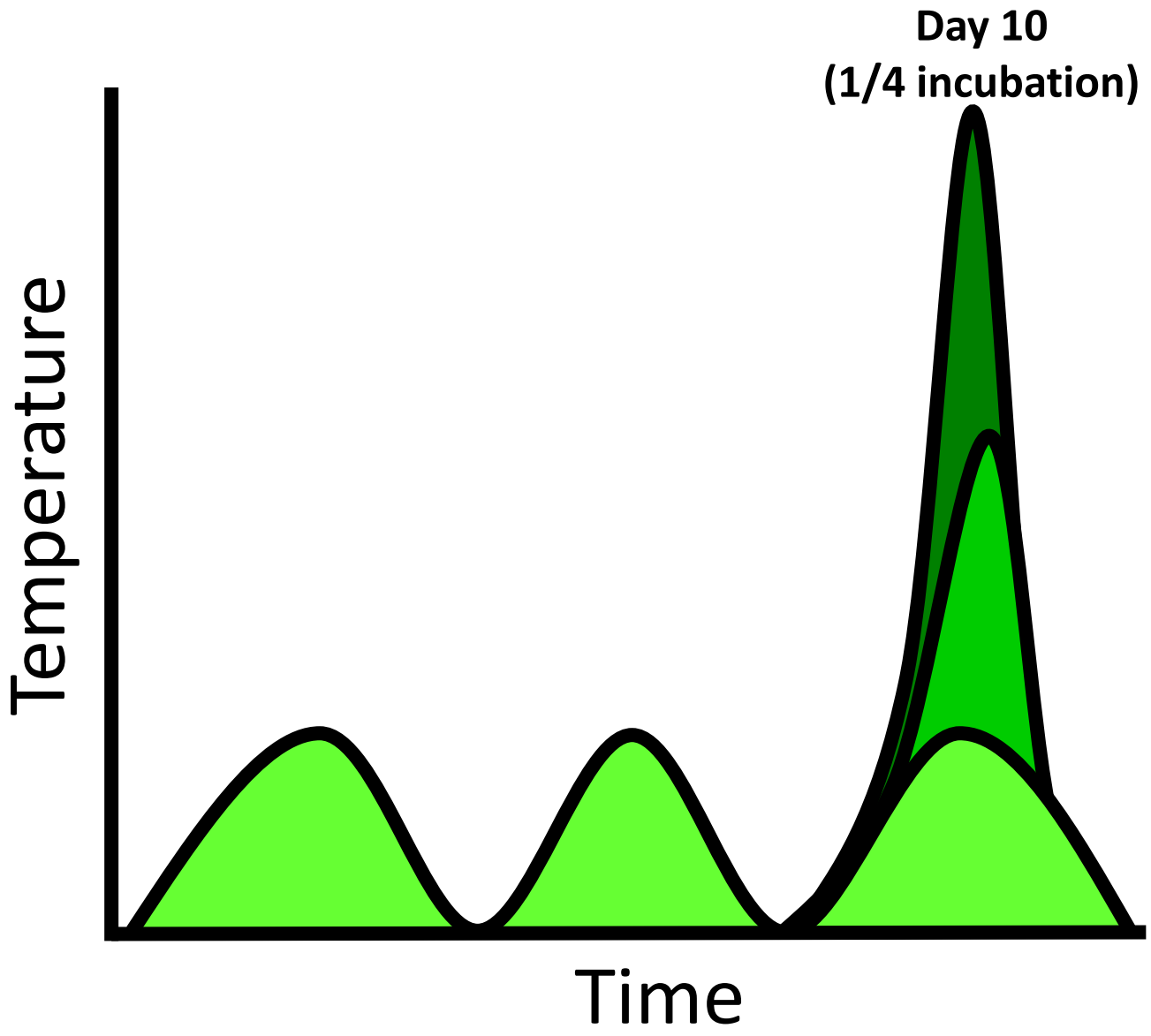

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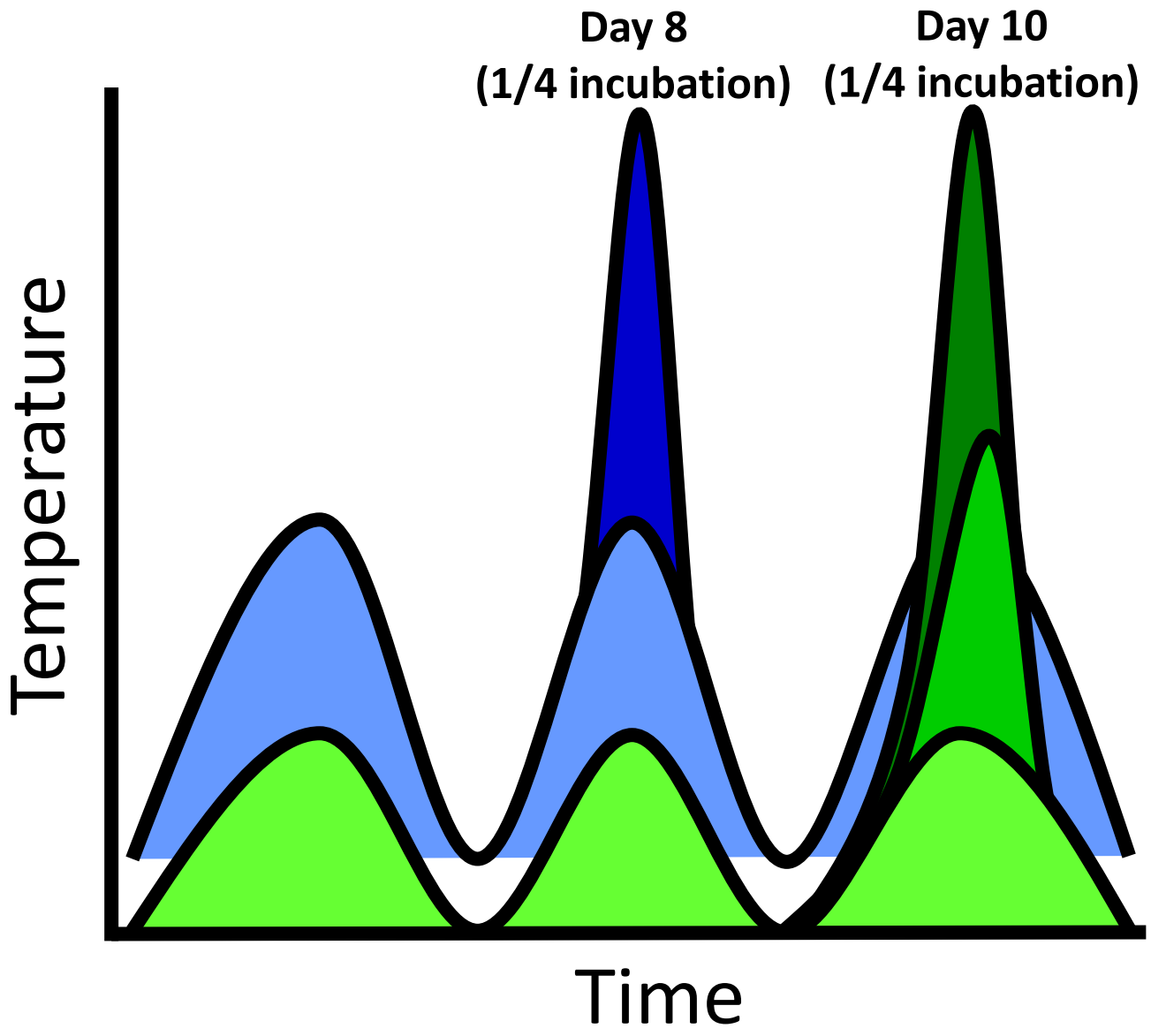
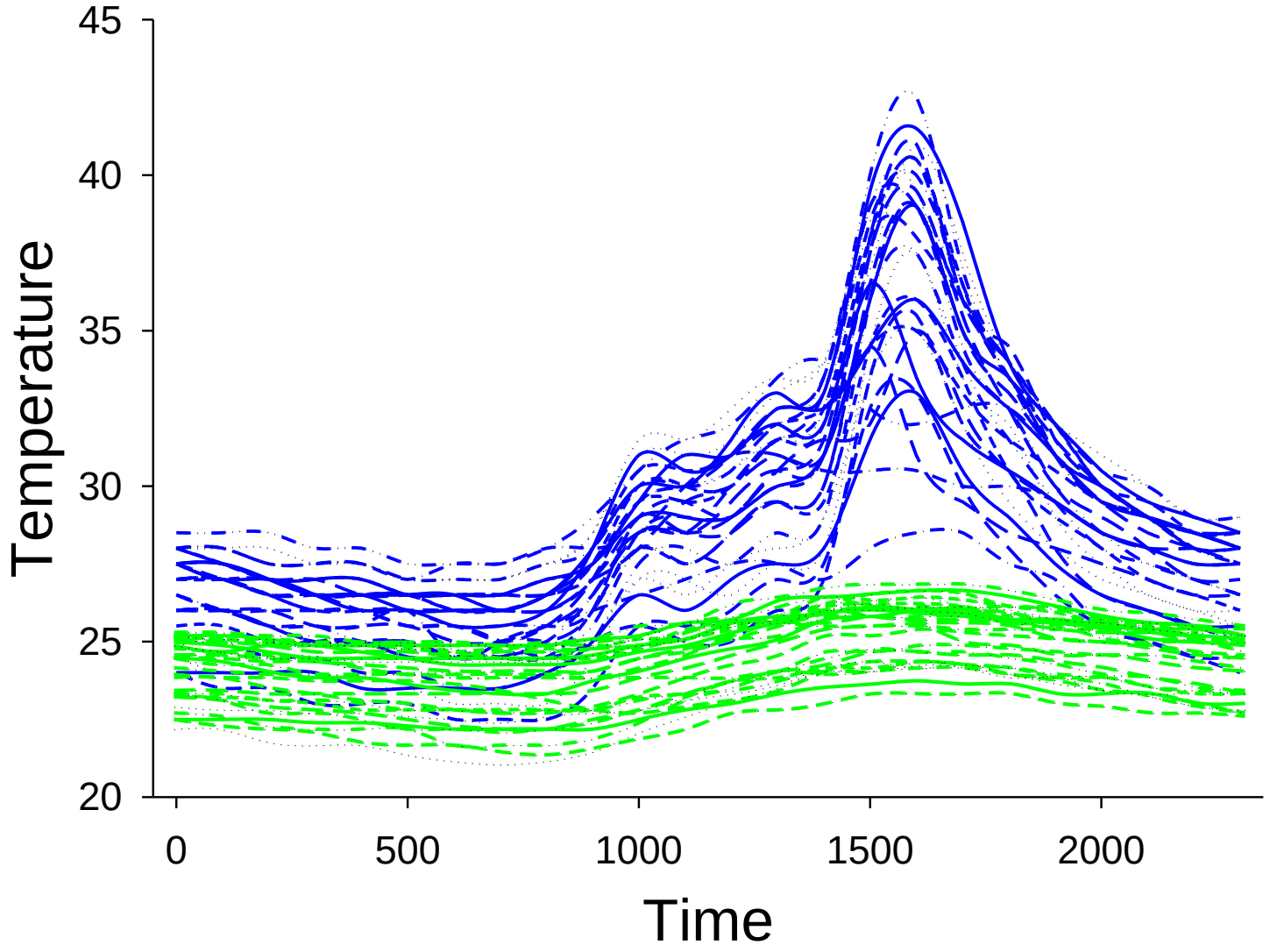


Thermal Profiles



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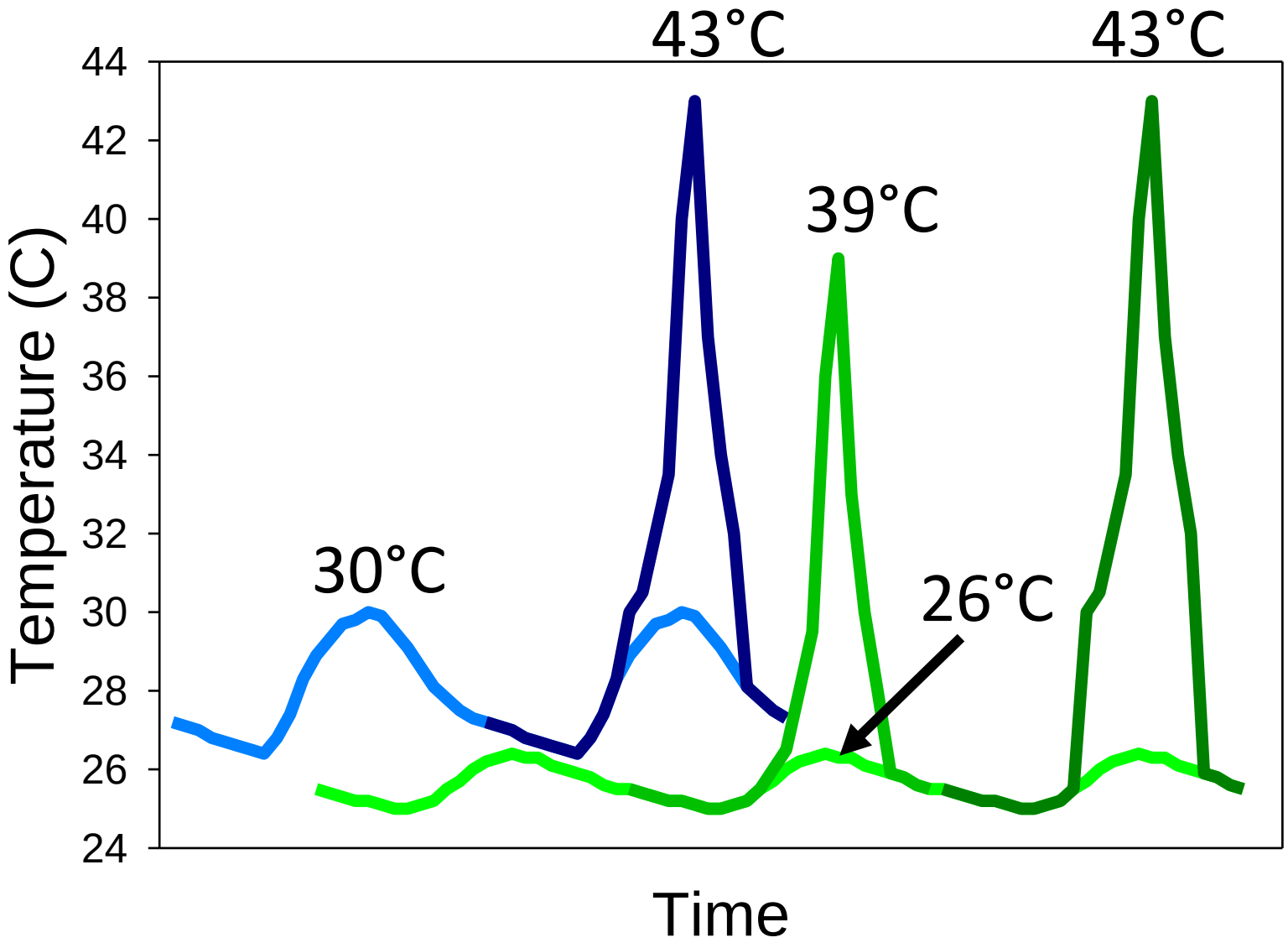
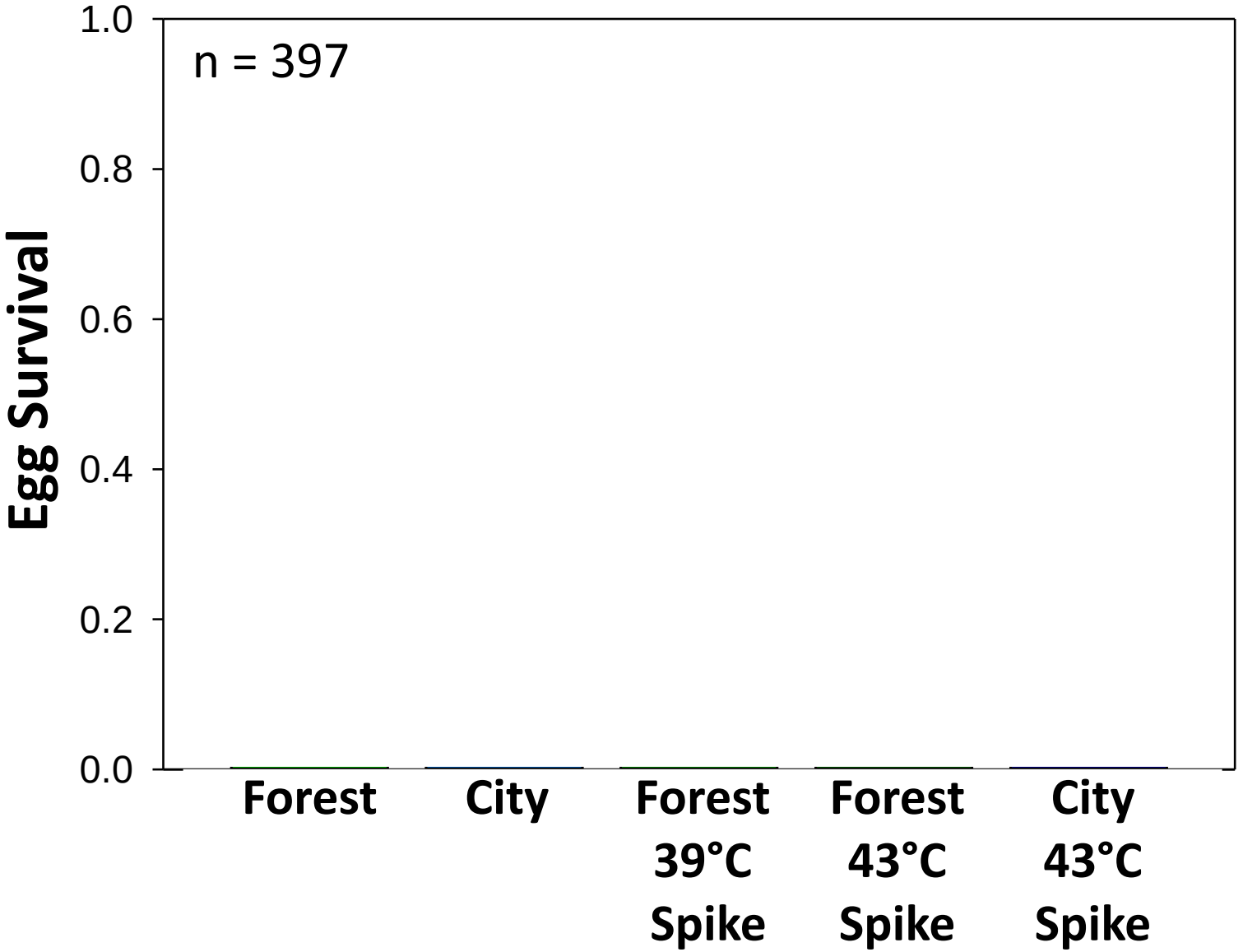
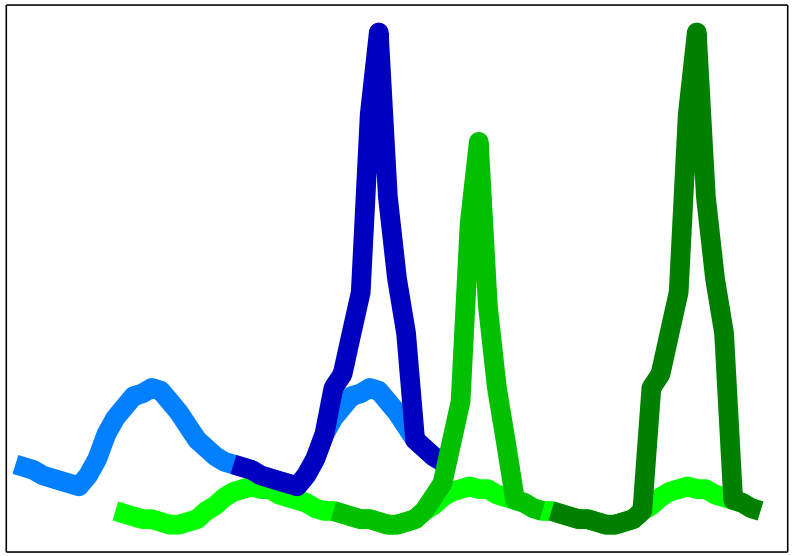


Egg Survival





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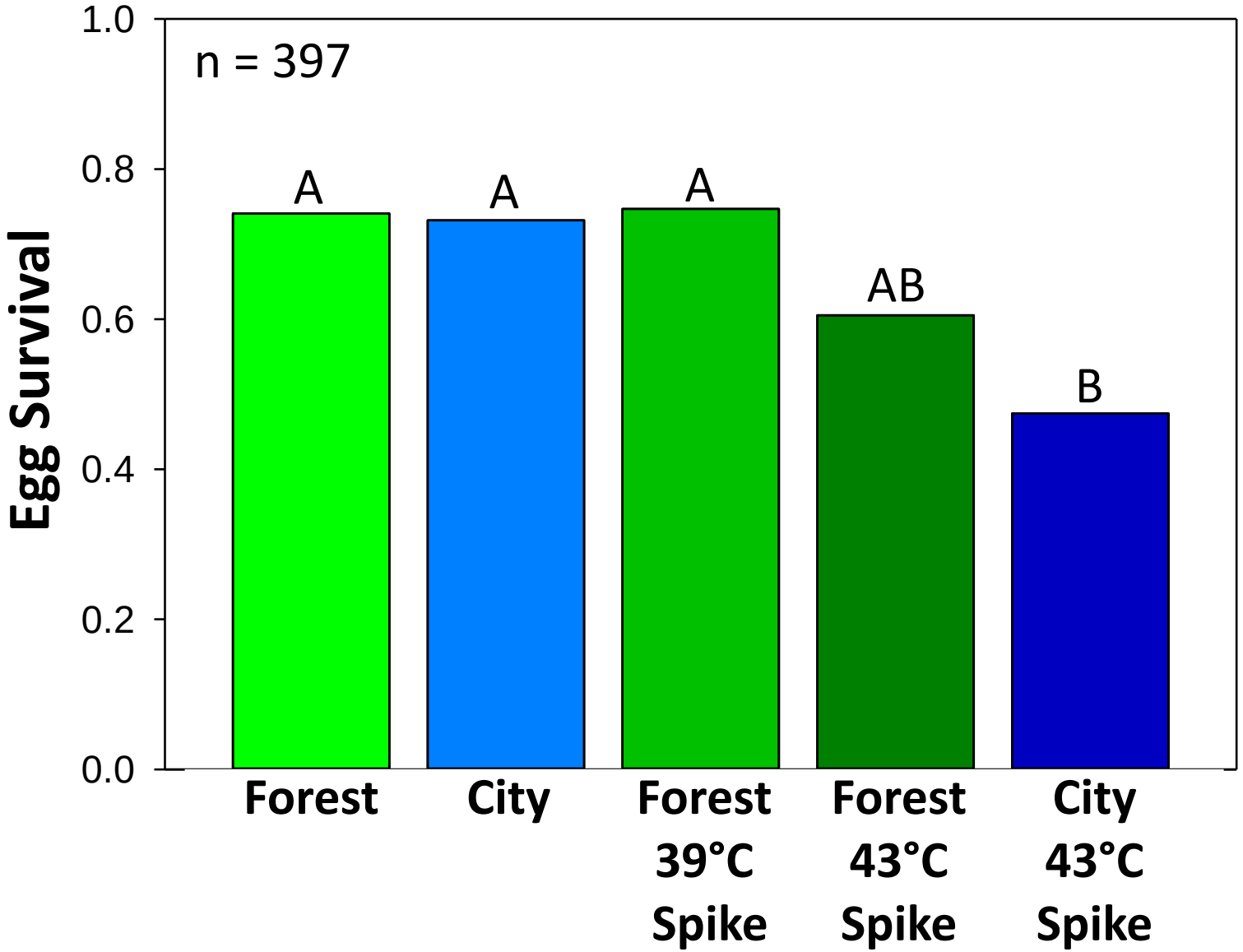
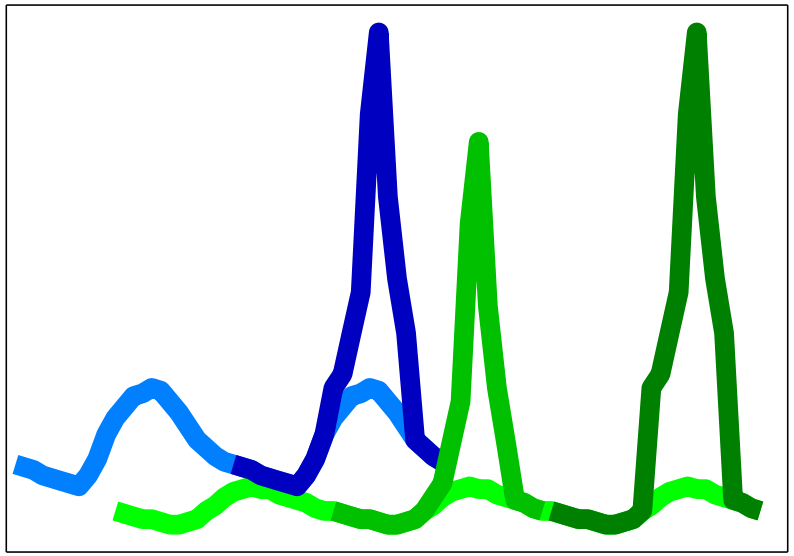
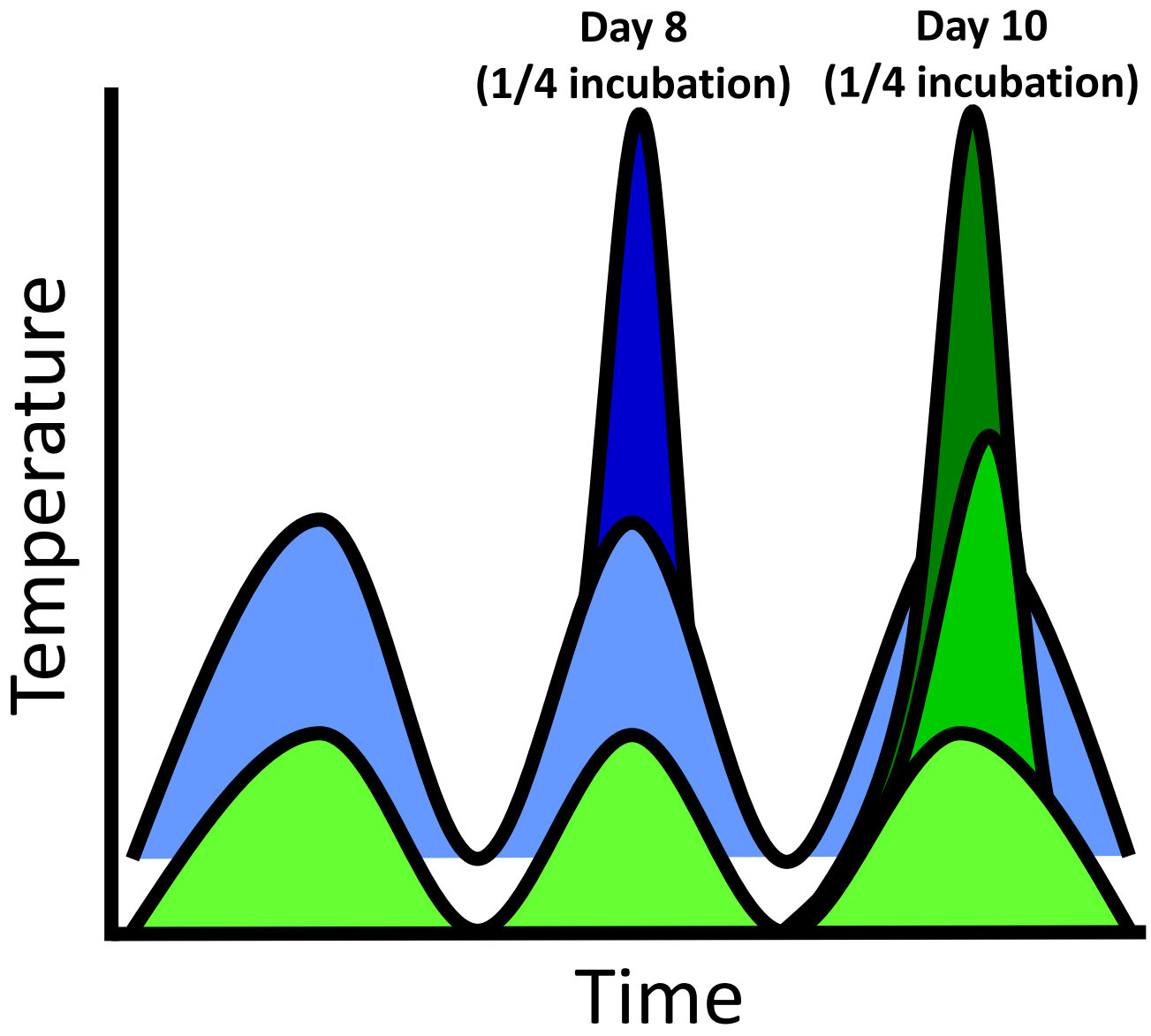




Survival dependent on magnitude of spike and thermal background

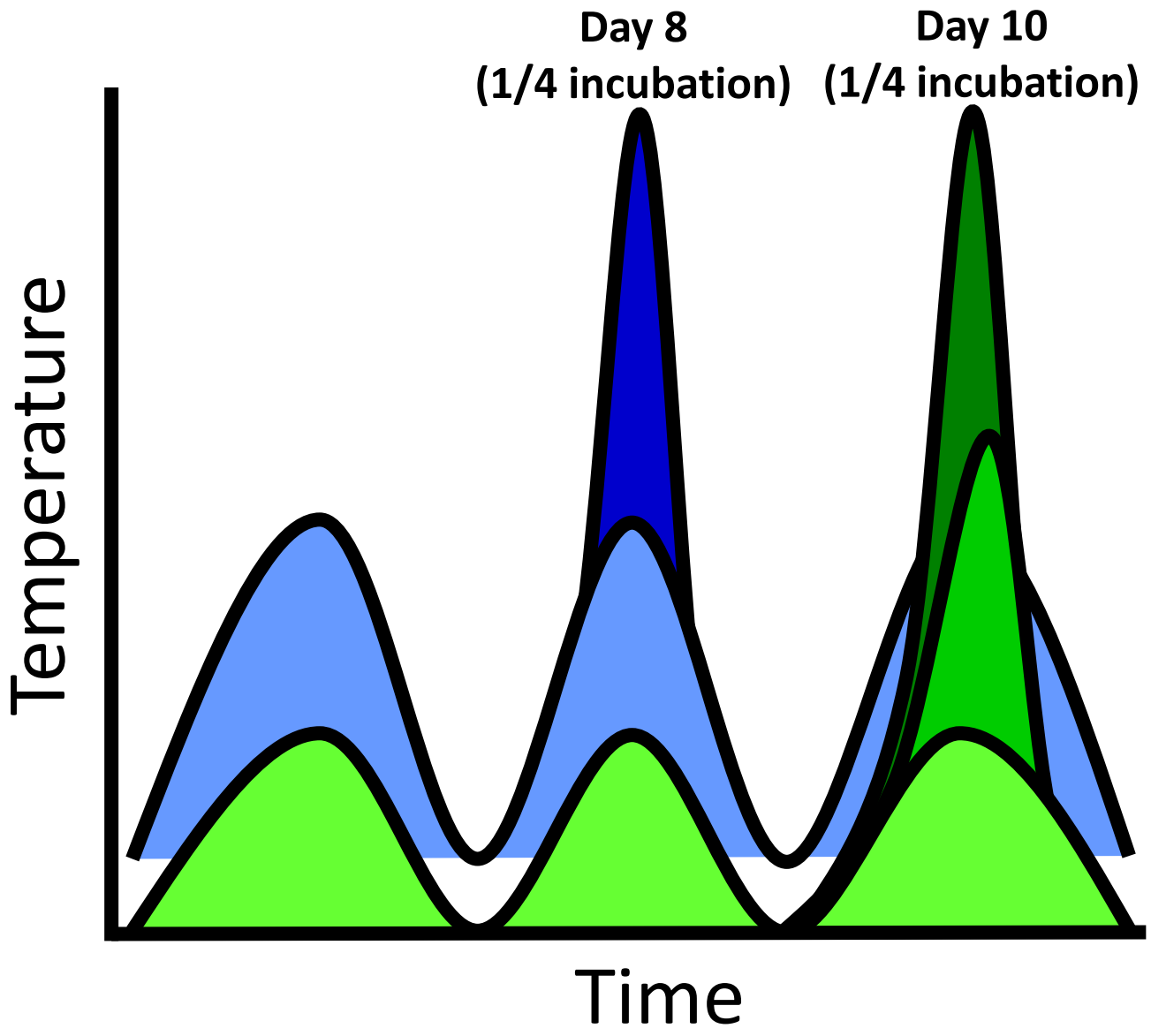
Ecophysiology



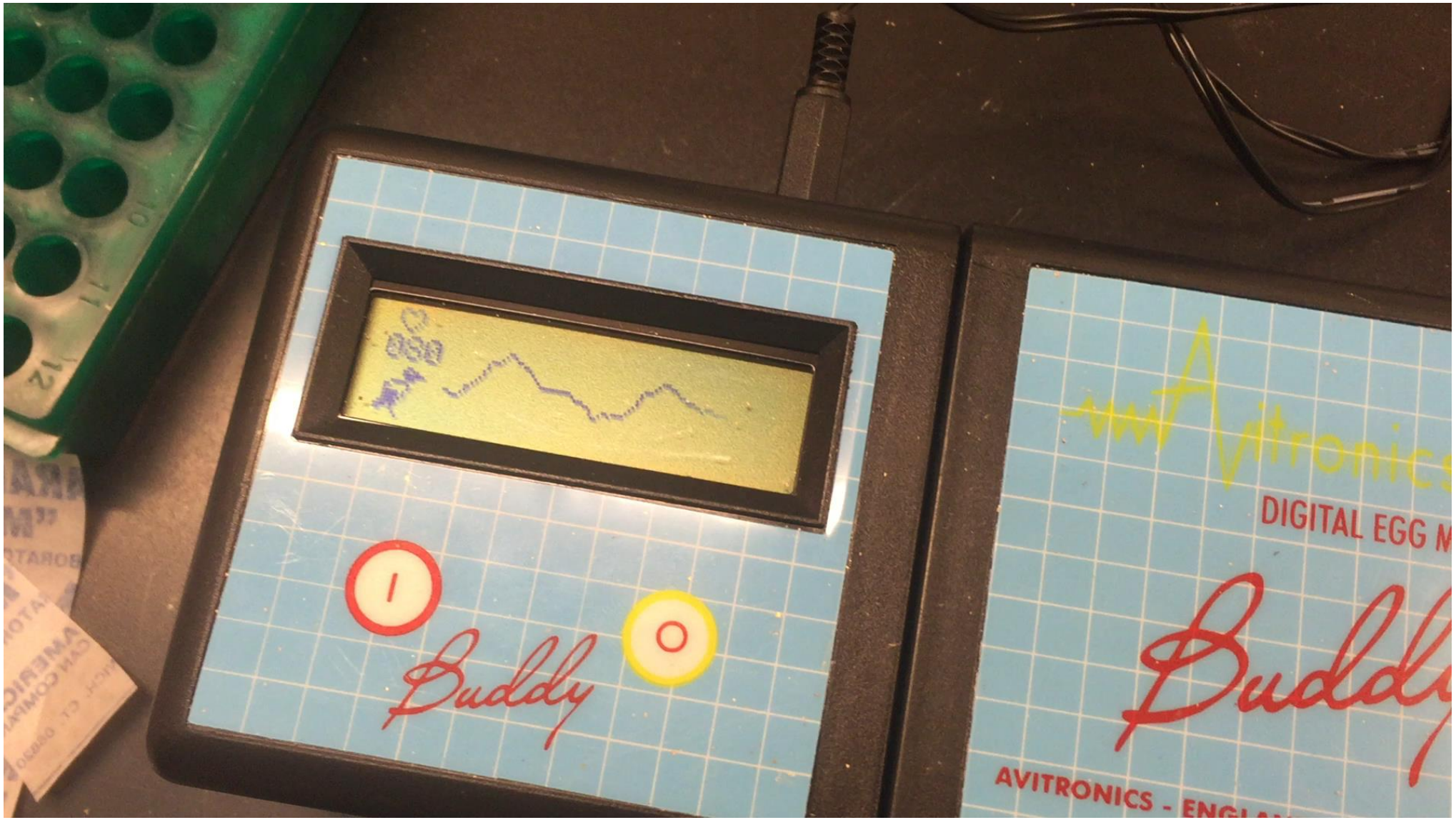
Ecophysiology

Questions

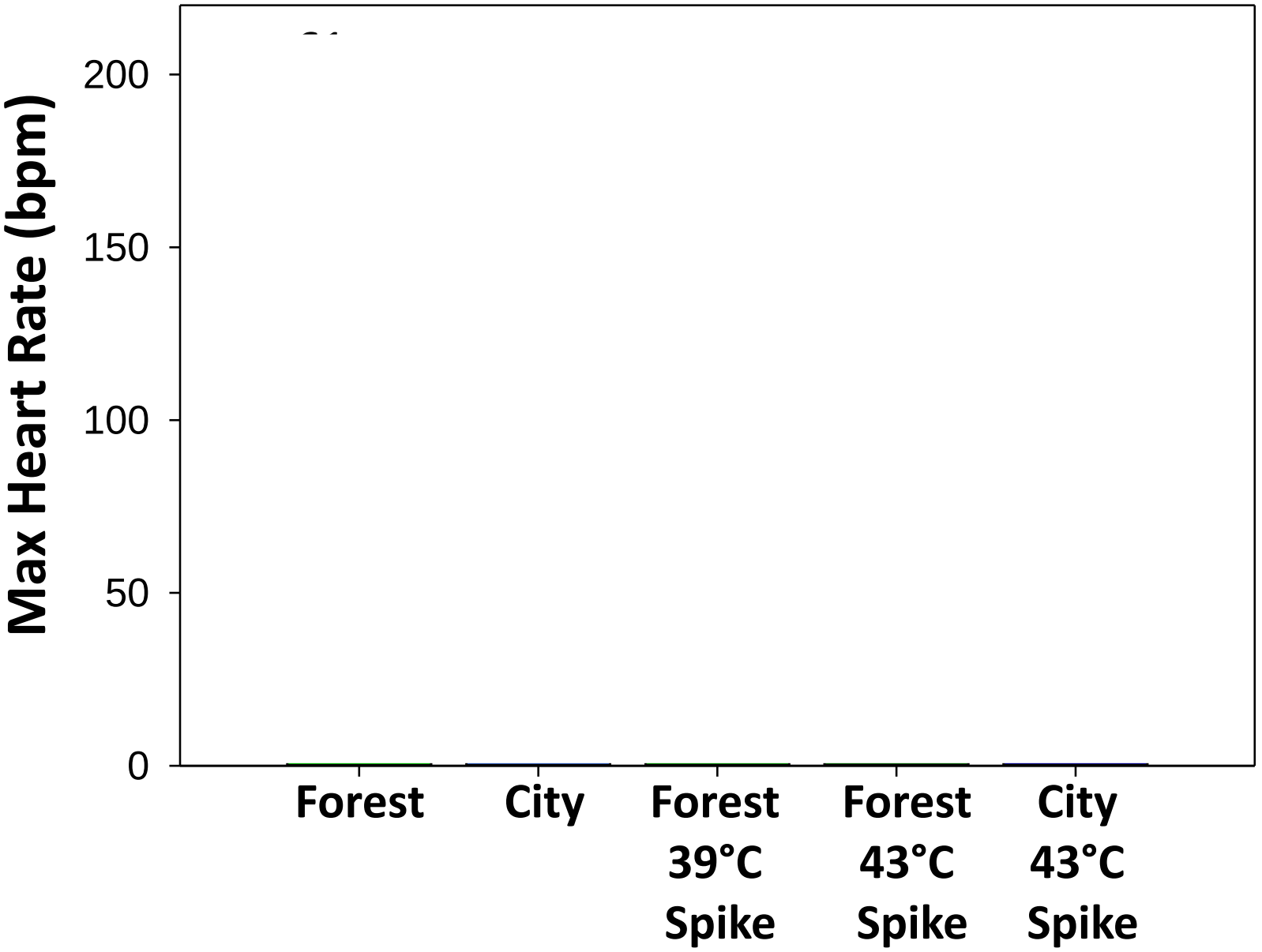
- What are the physiological responses to thermal spikes?
- Are responses or effects persistent?
  - In embryological development?
  - Post-hatching?

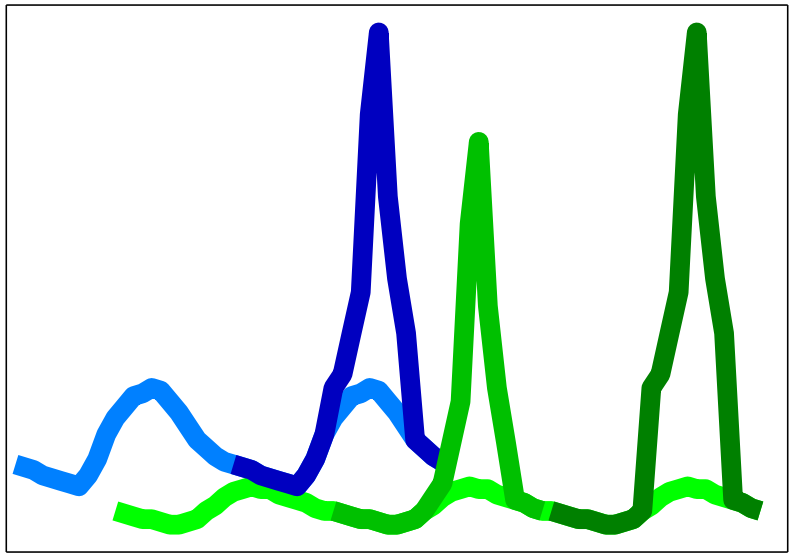


Non-invasive Measure of Heart Rate



Max Heart Rate





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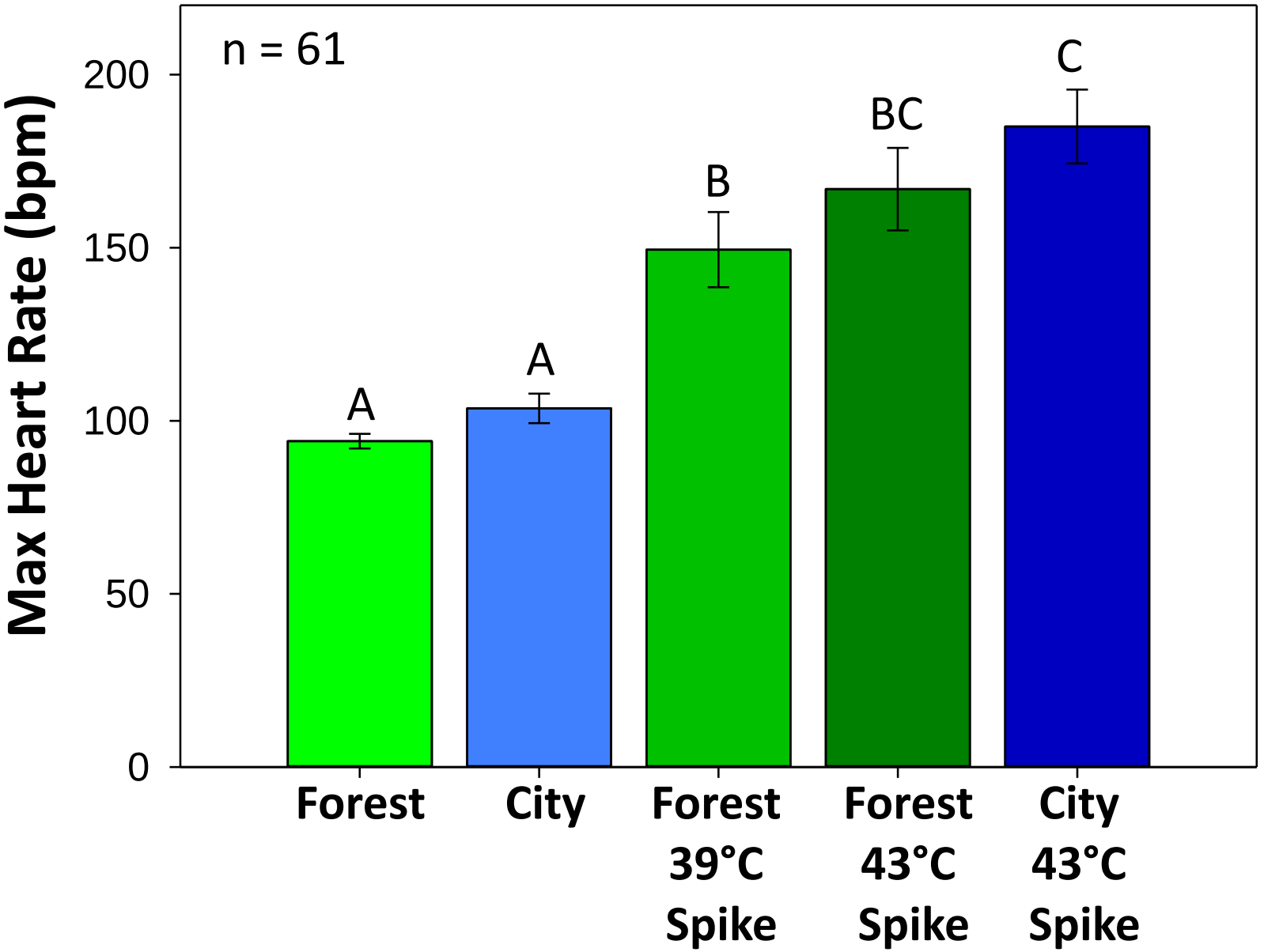
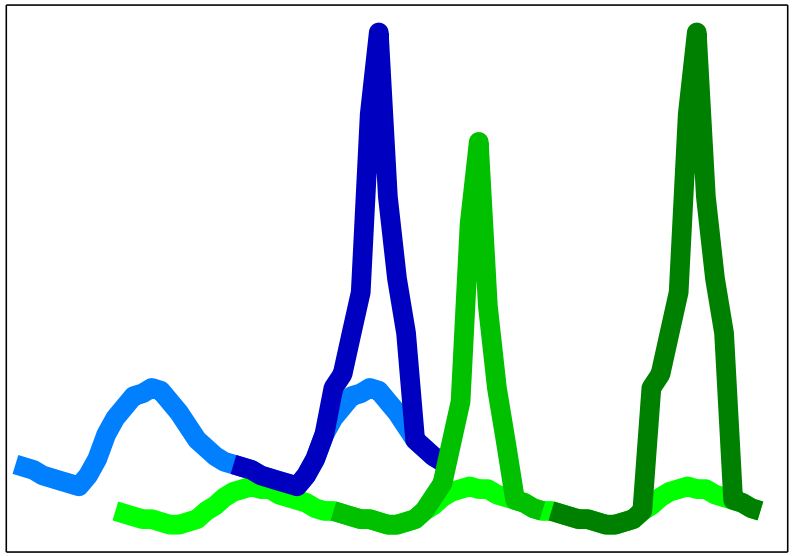
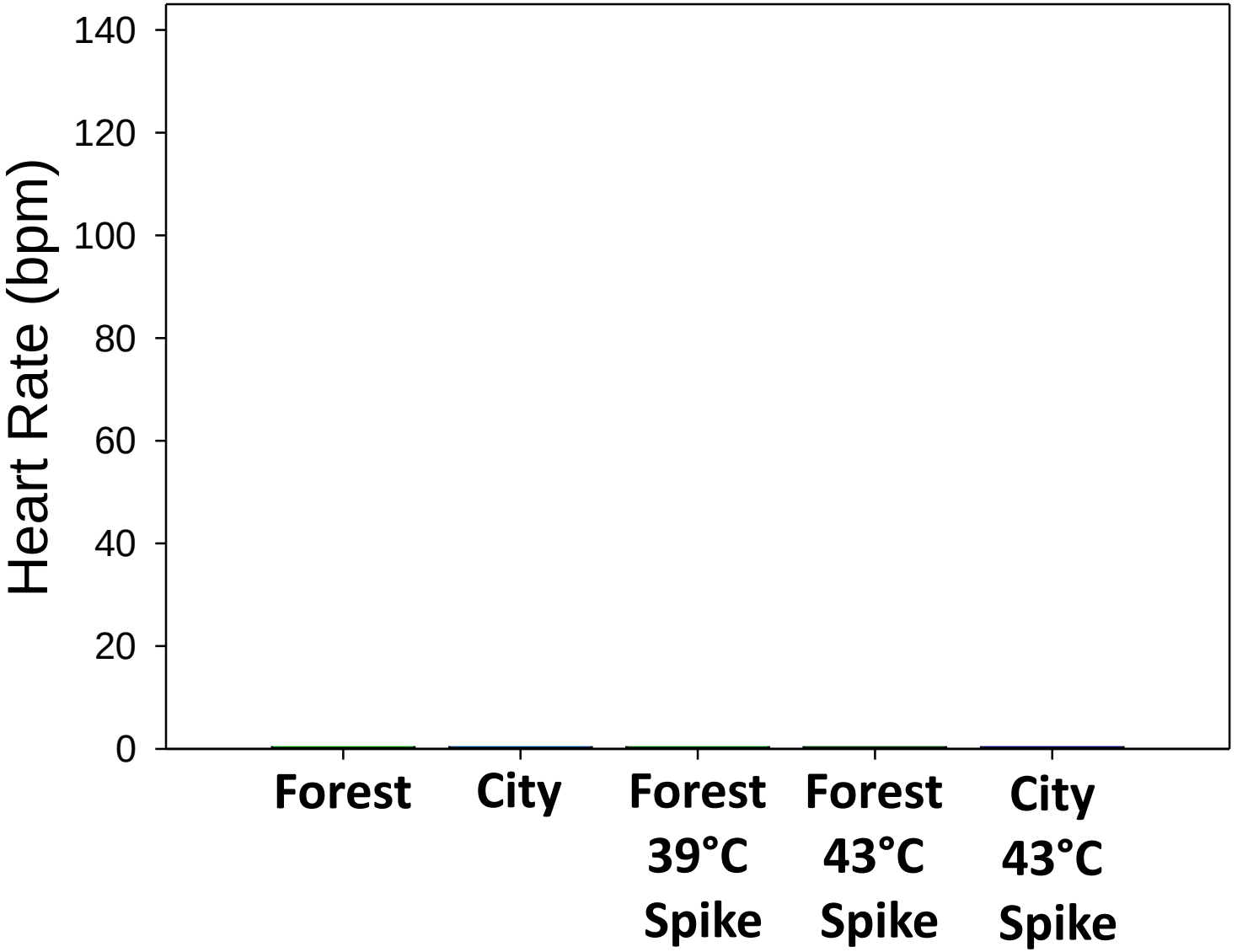
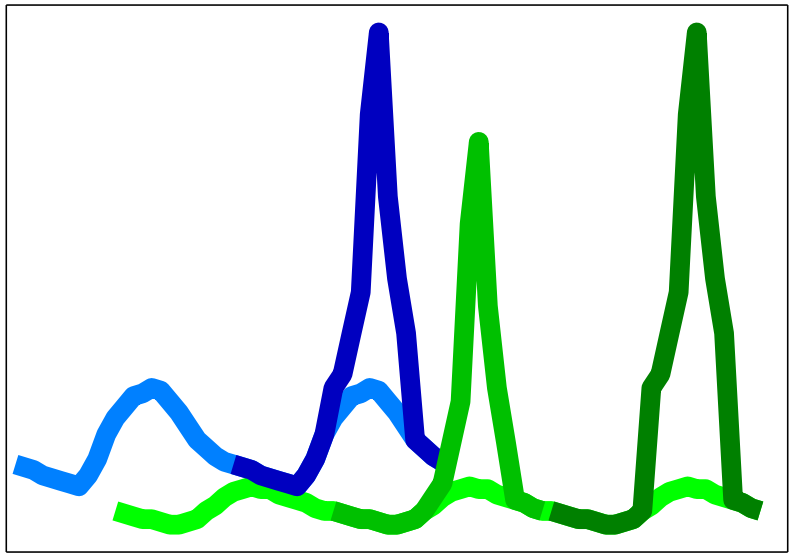




Spikes significantly increase embryo heart rates

Baseline Heart Rate





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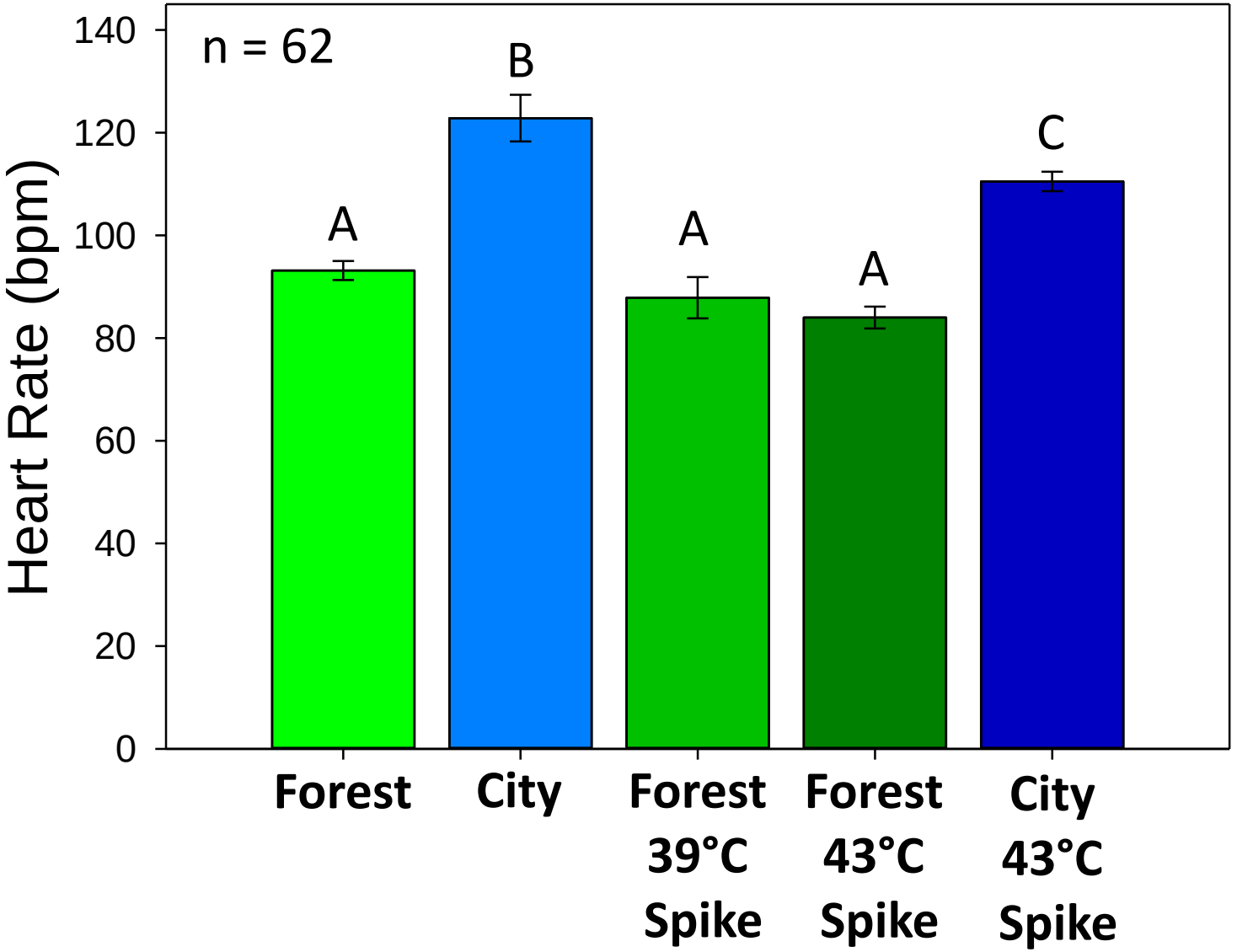
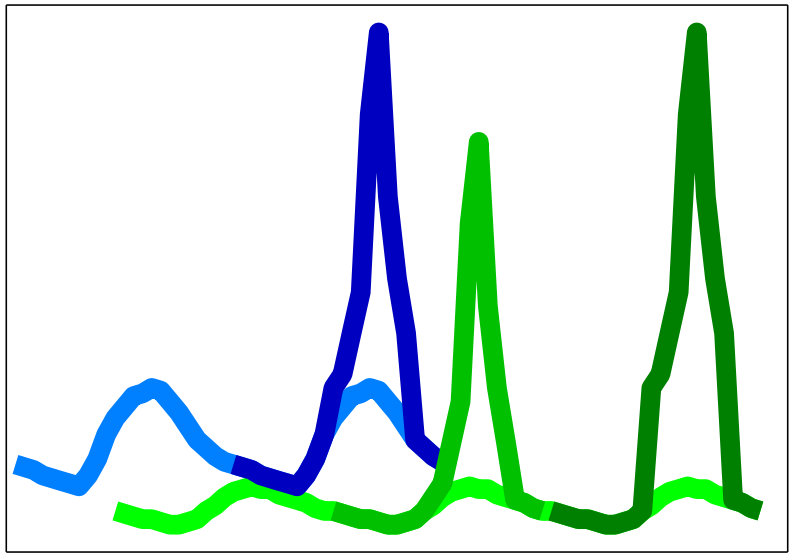
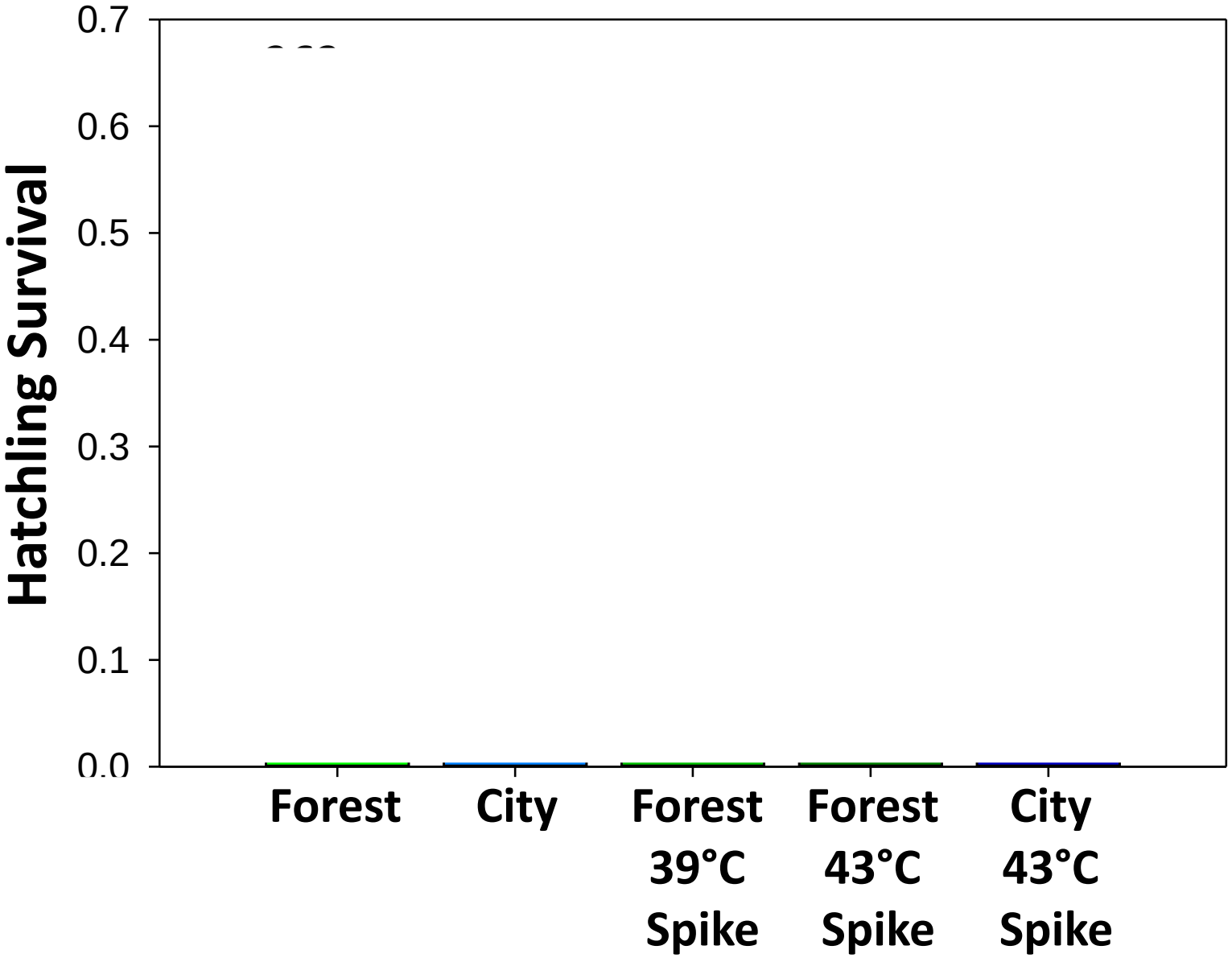
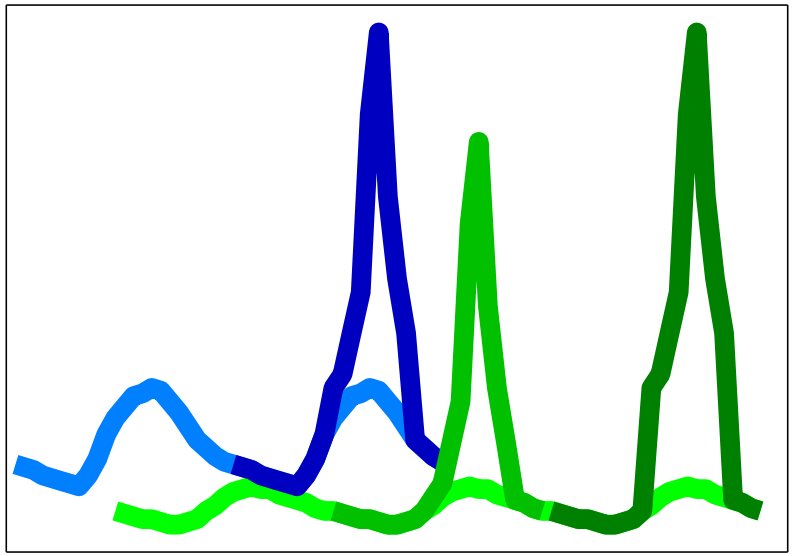




Spikes reduce heart rate for at least 24 hours

Hatchling Survival





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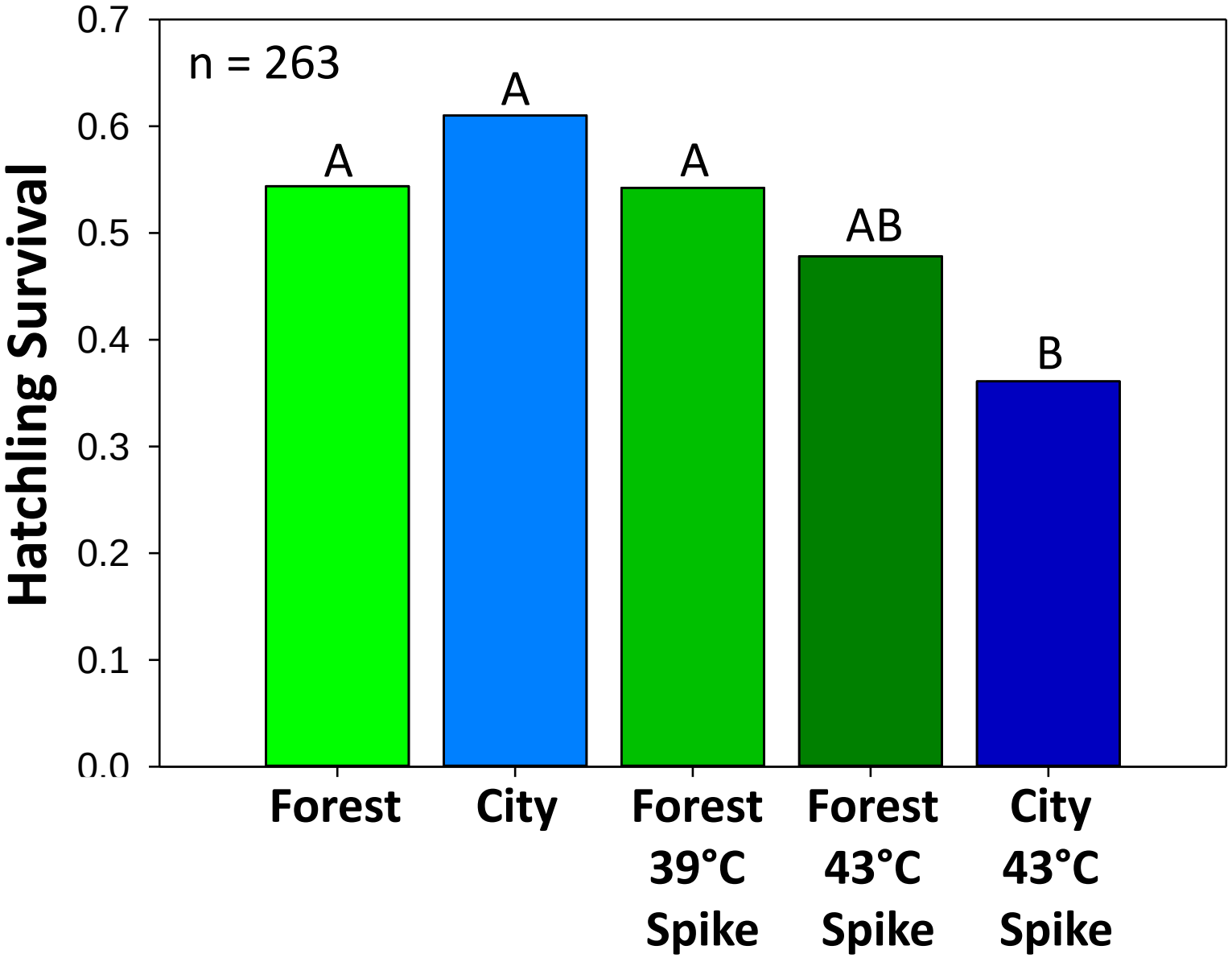
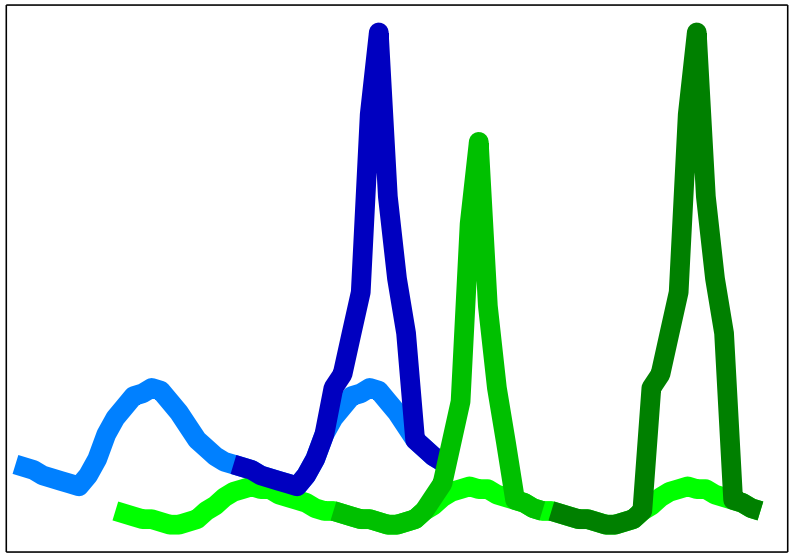
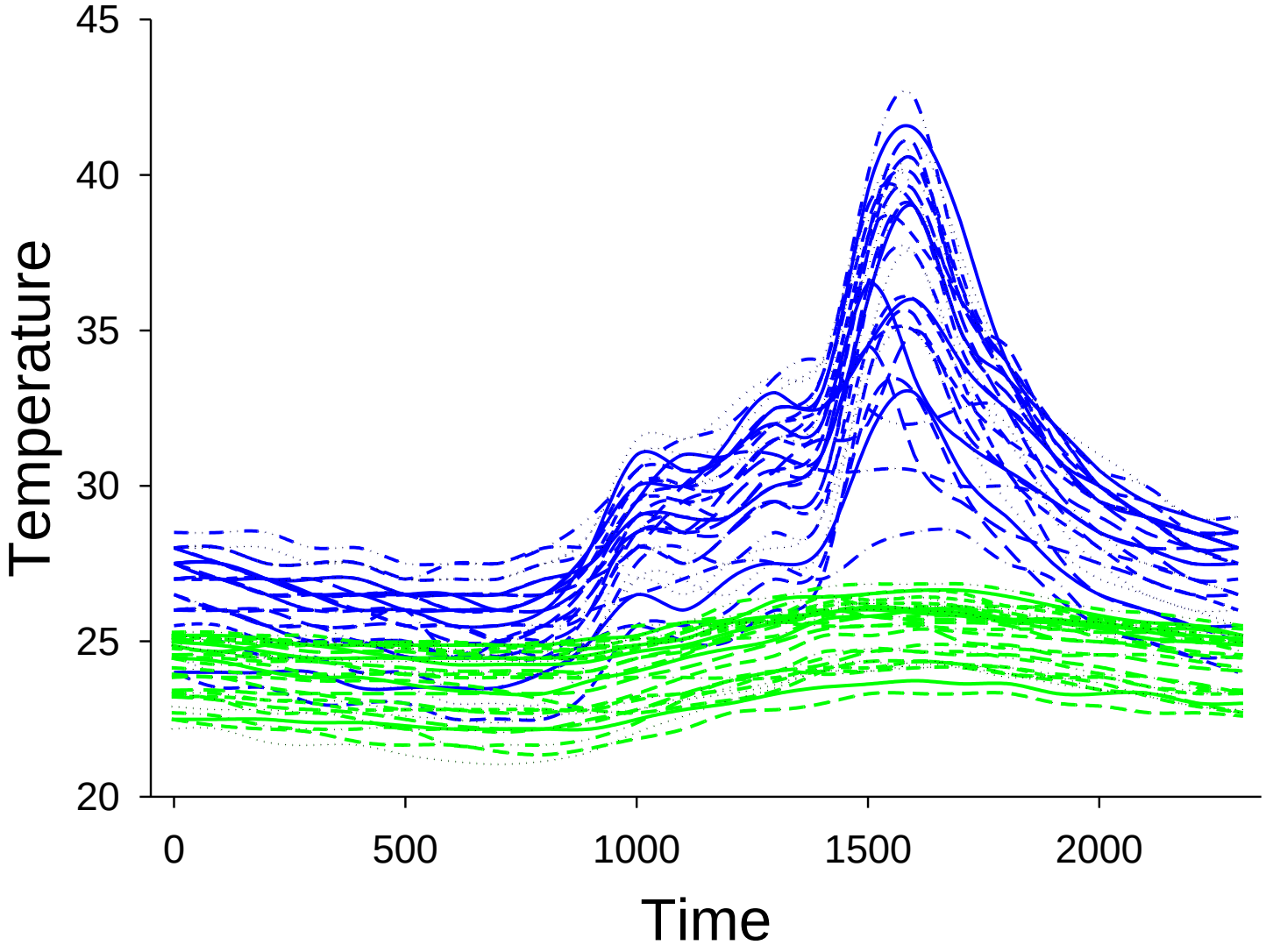




Hatchling survival also dependent on magnitude of spike and thermal background

Results



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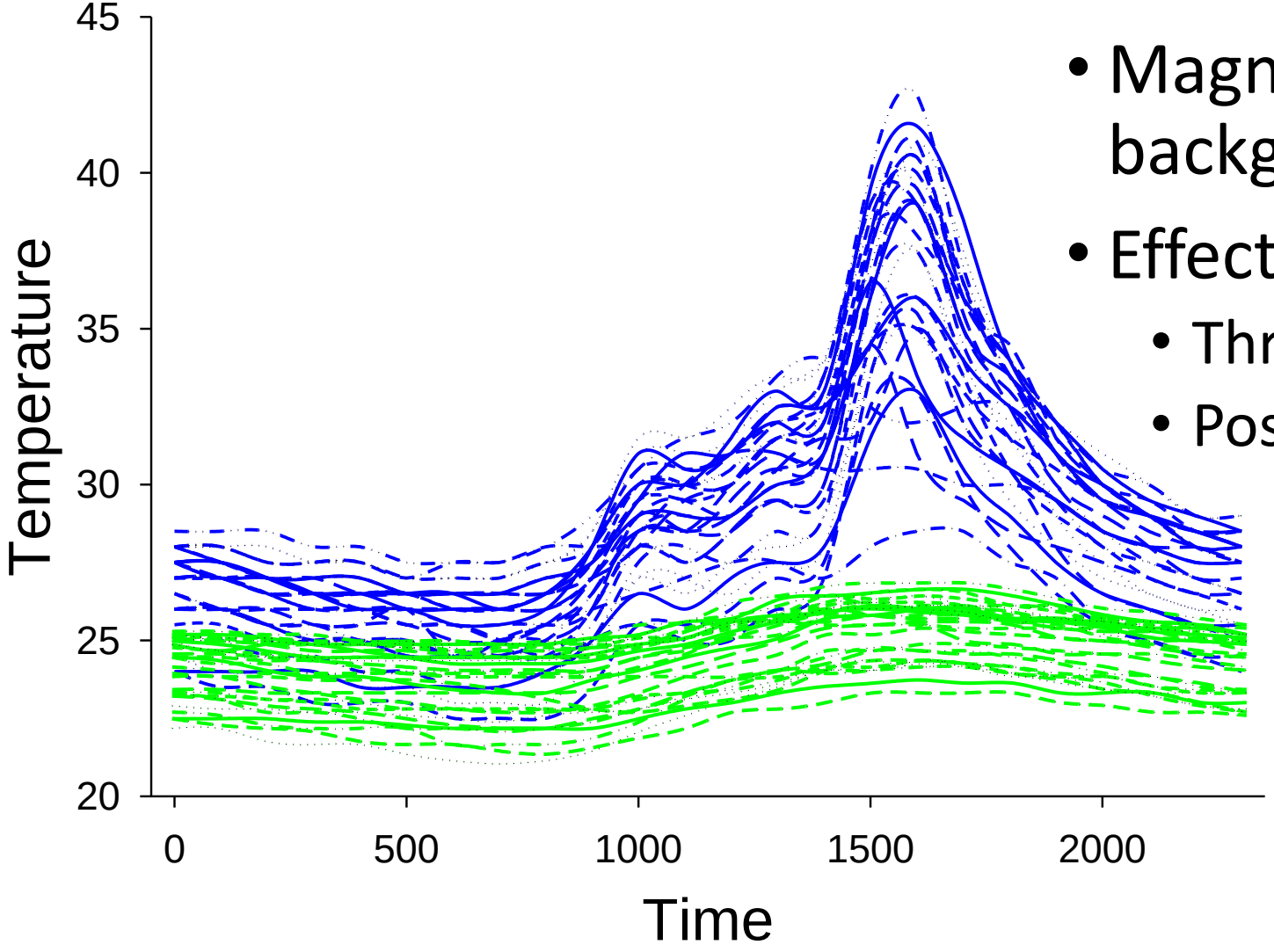
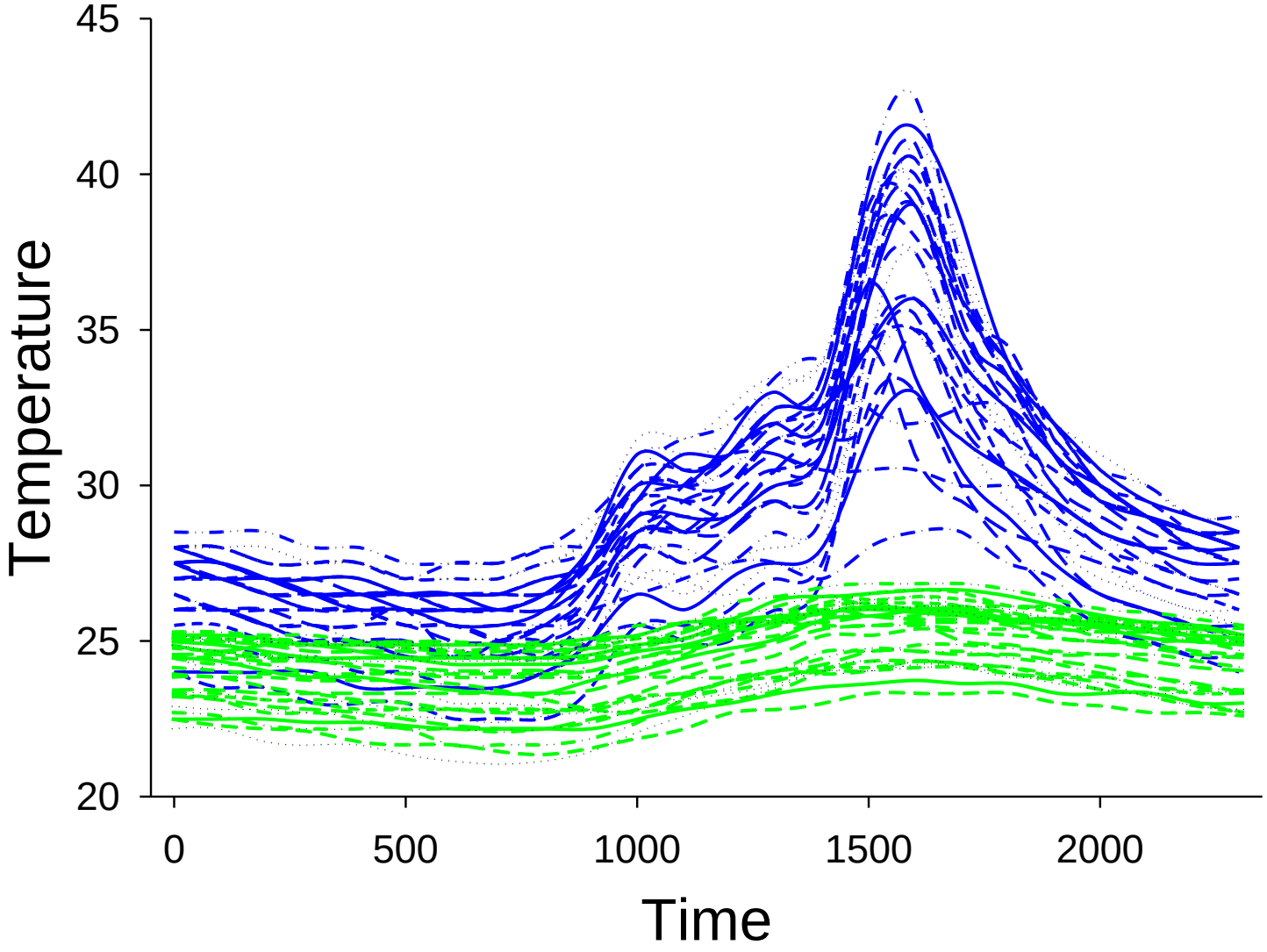


- Brief thermal spikes decrease egg survival
- Magnitude of spike and thermal background likely important
- Effects of thermal spikes can persist
  - Through embryonic development
  - Post-hatching

Discussion



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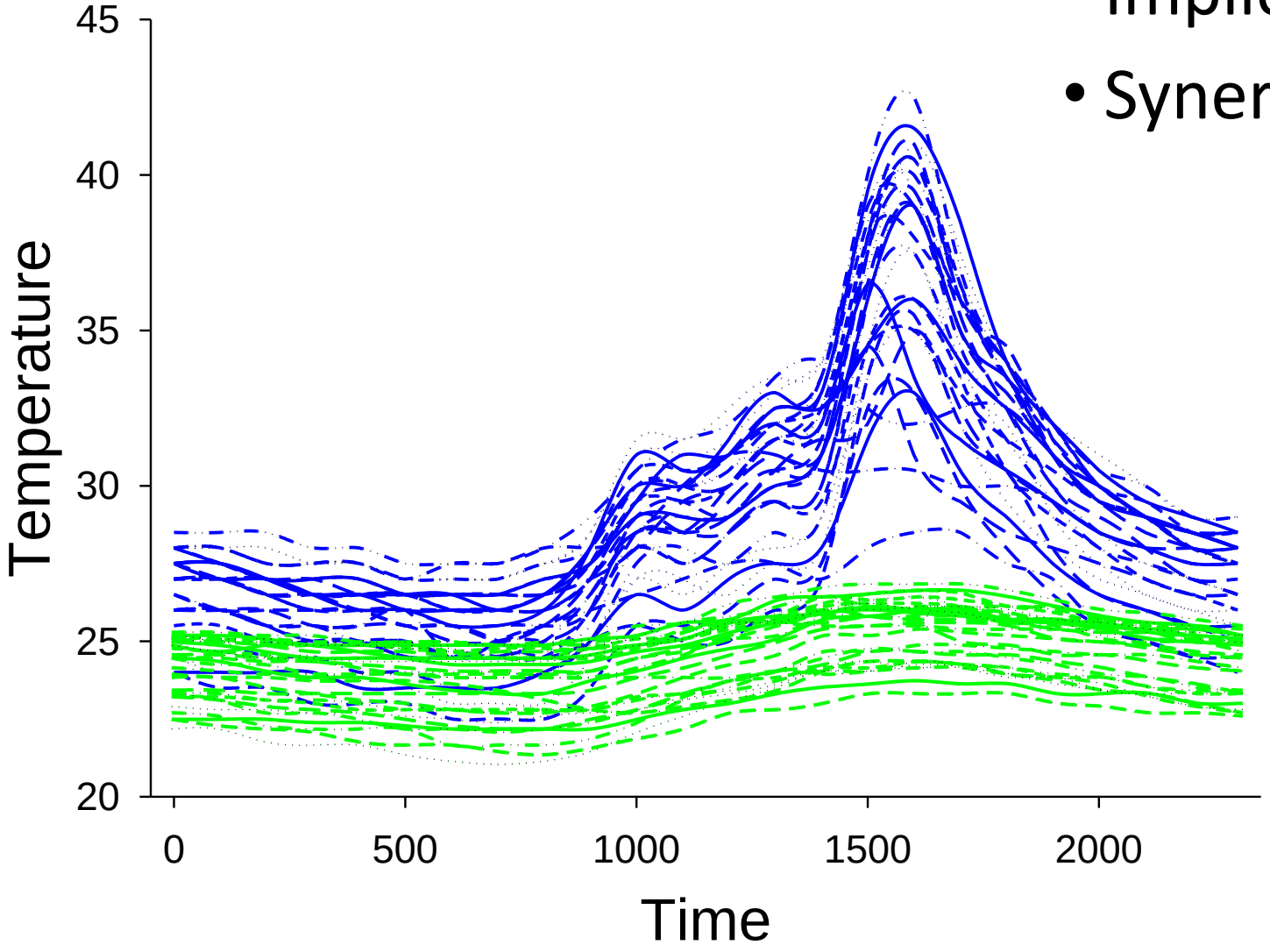
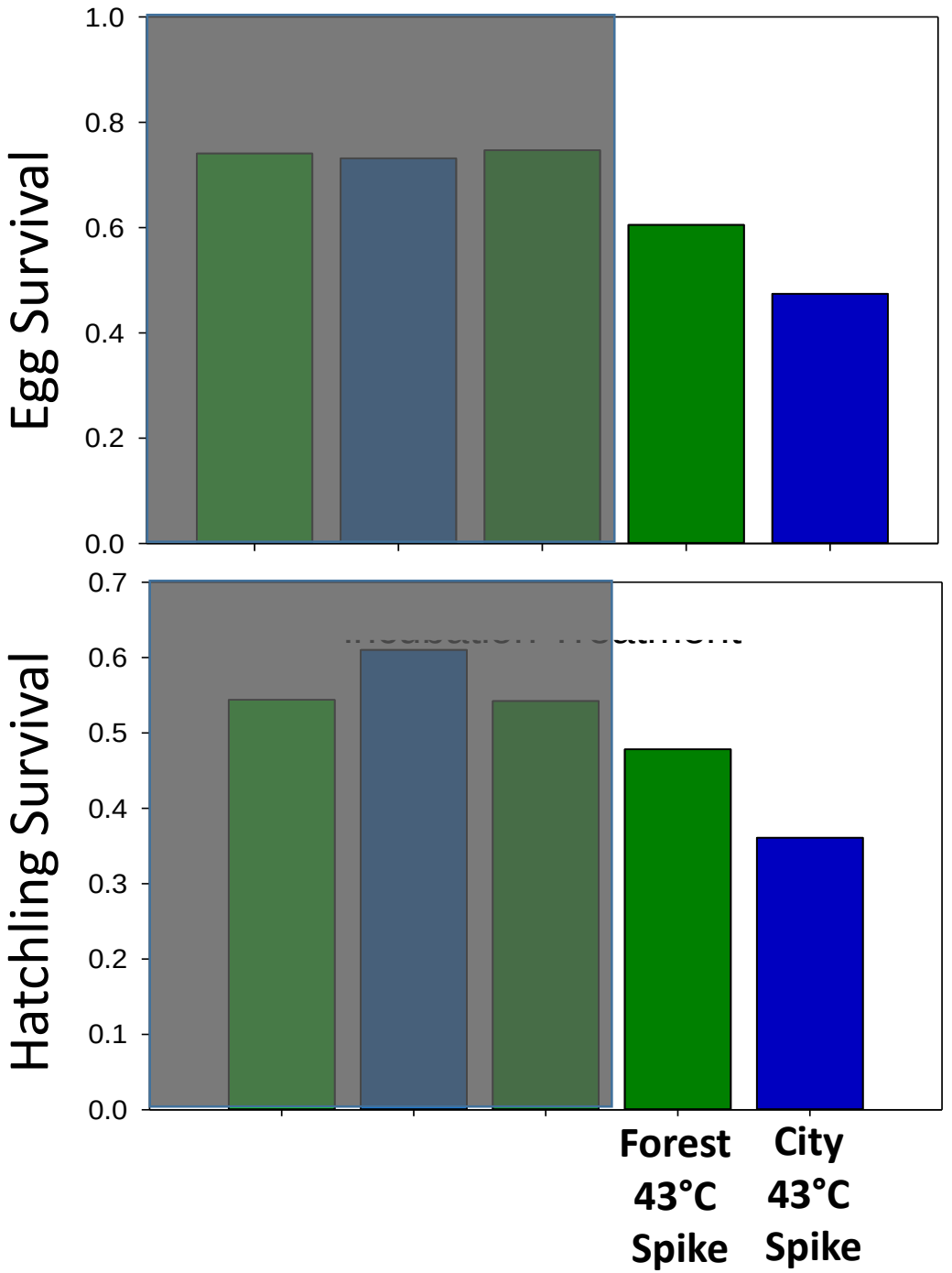


- Implications for Urbanization
- Implications for Climate Change
- Synergistic effects

Discussion

- Potential Maladaptive Plasticity



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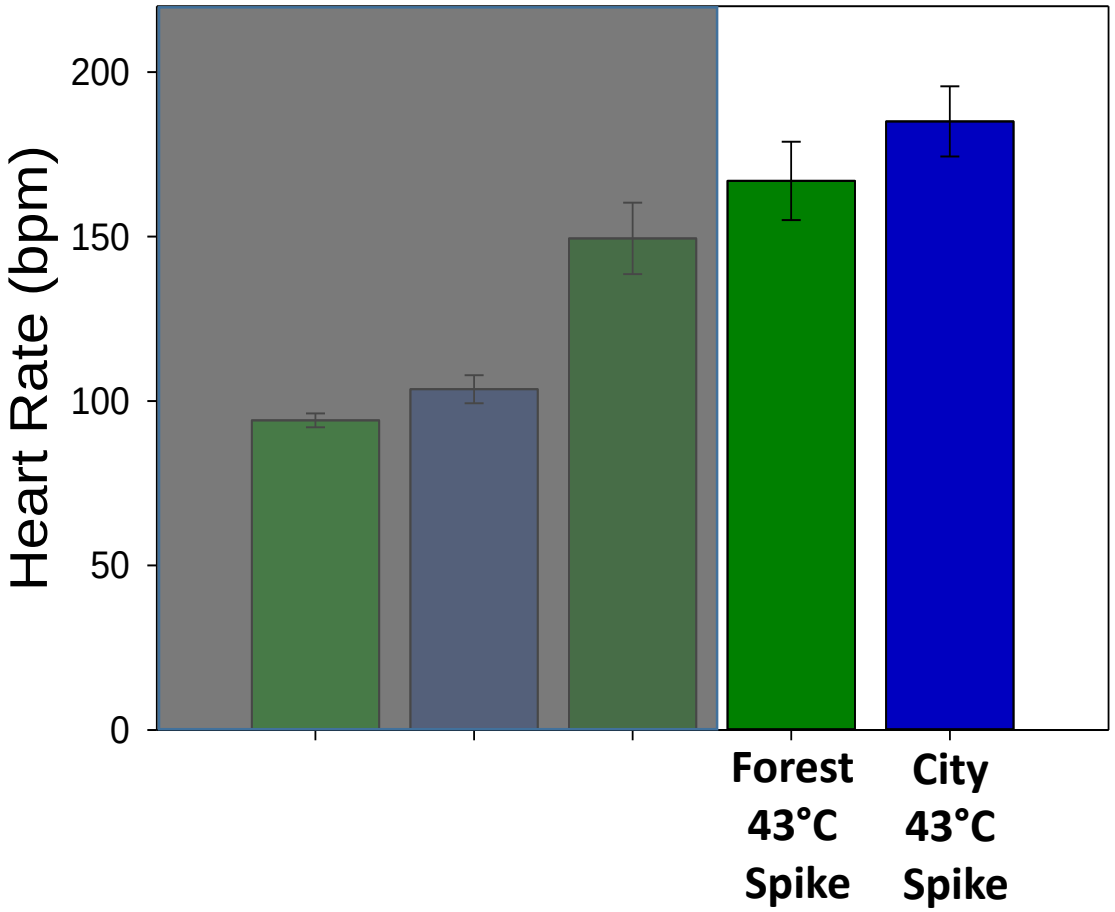

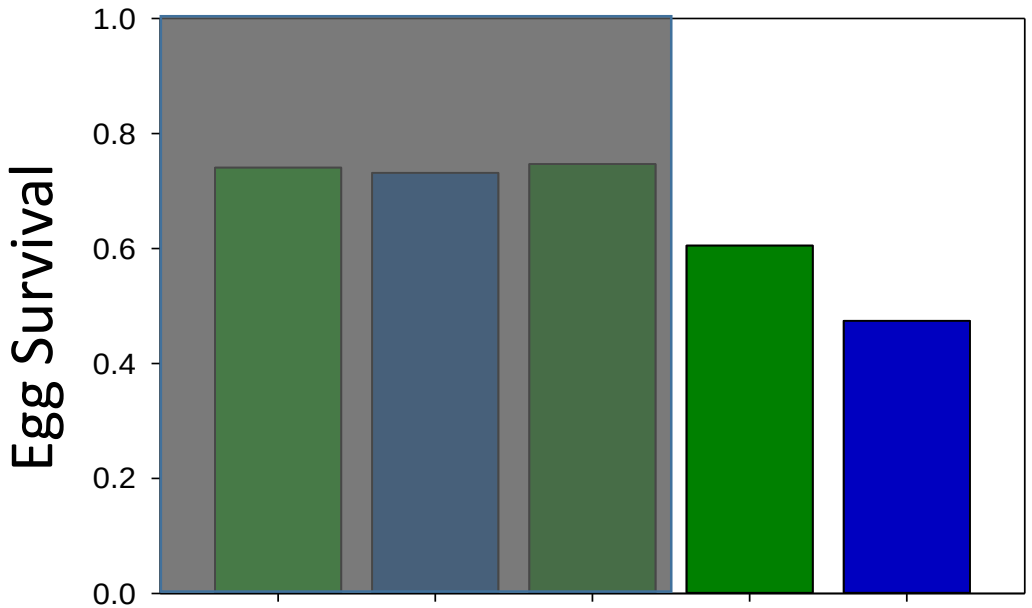

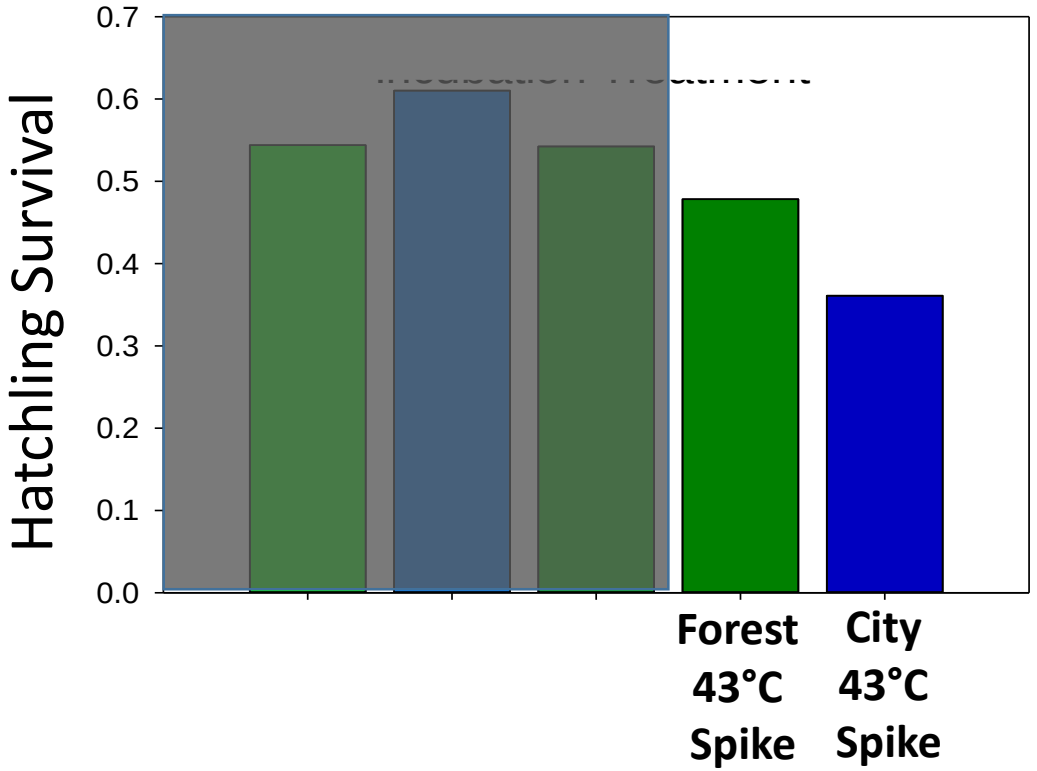

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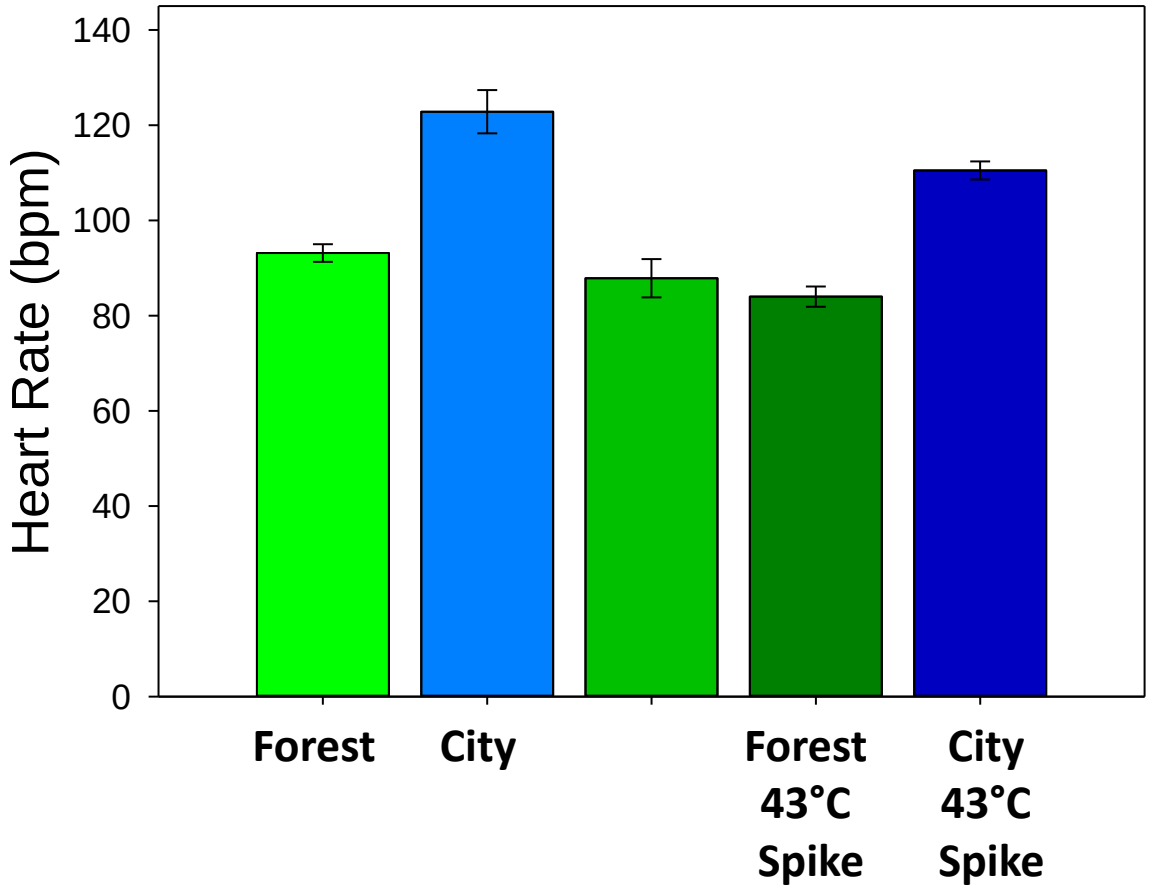

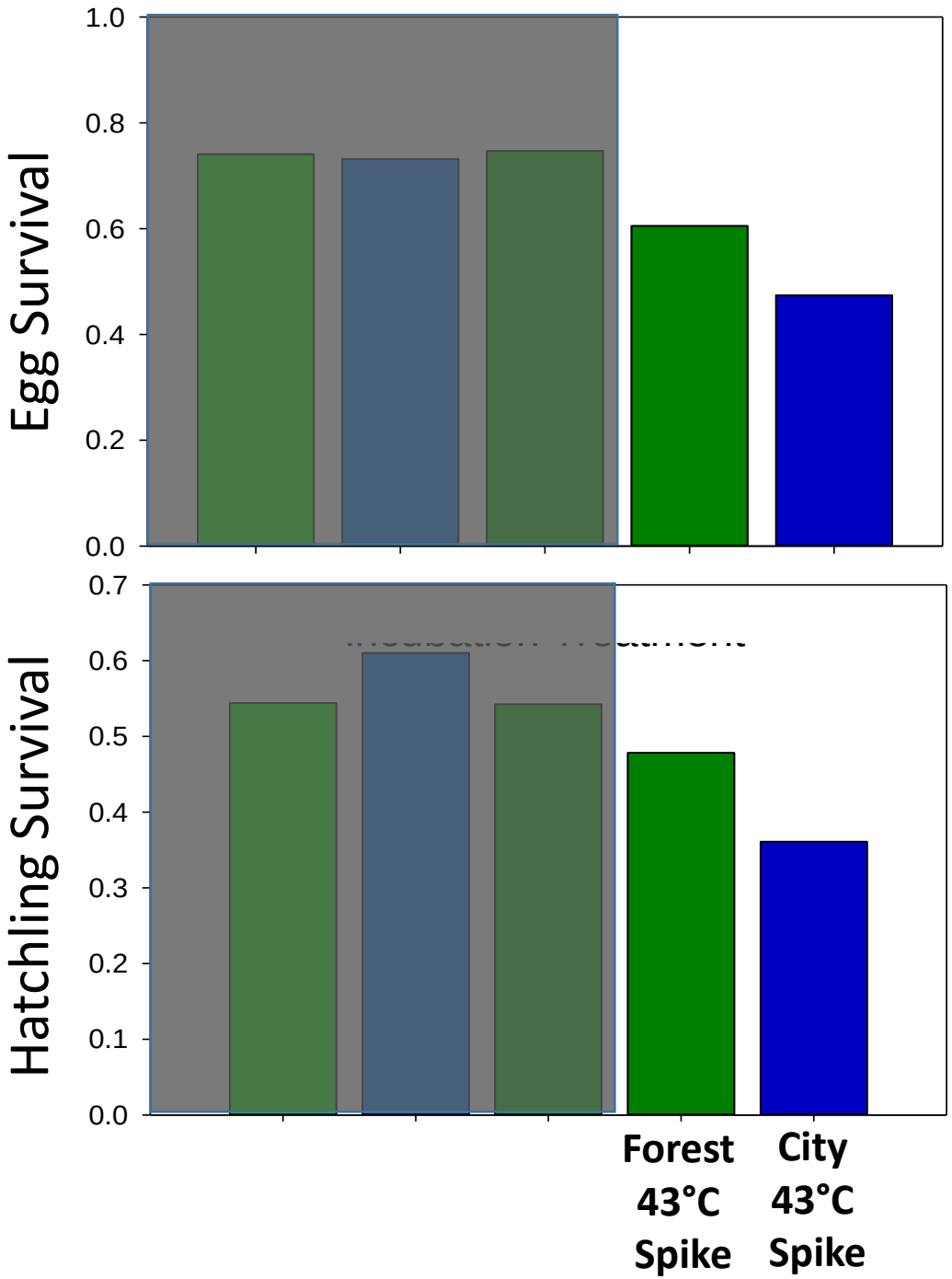

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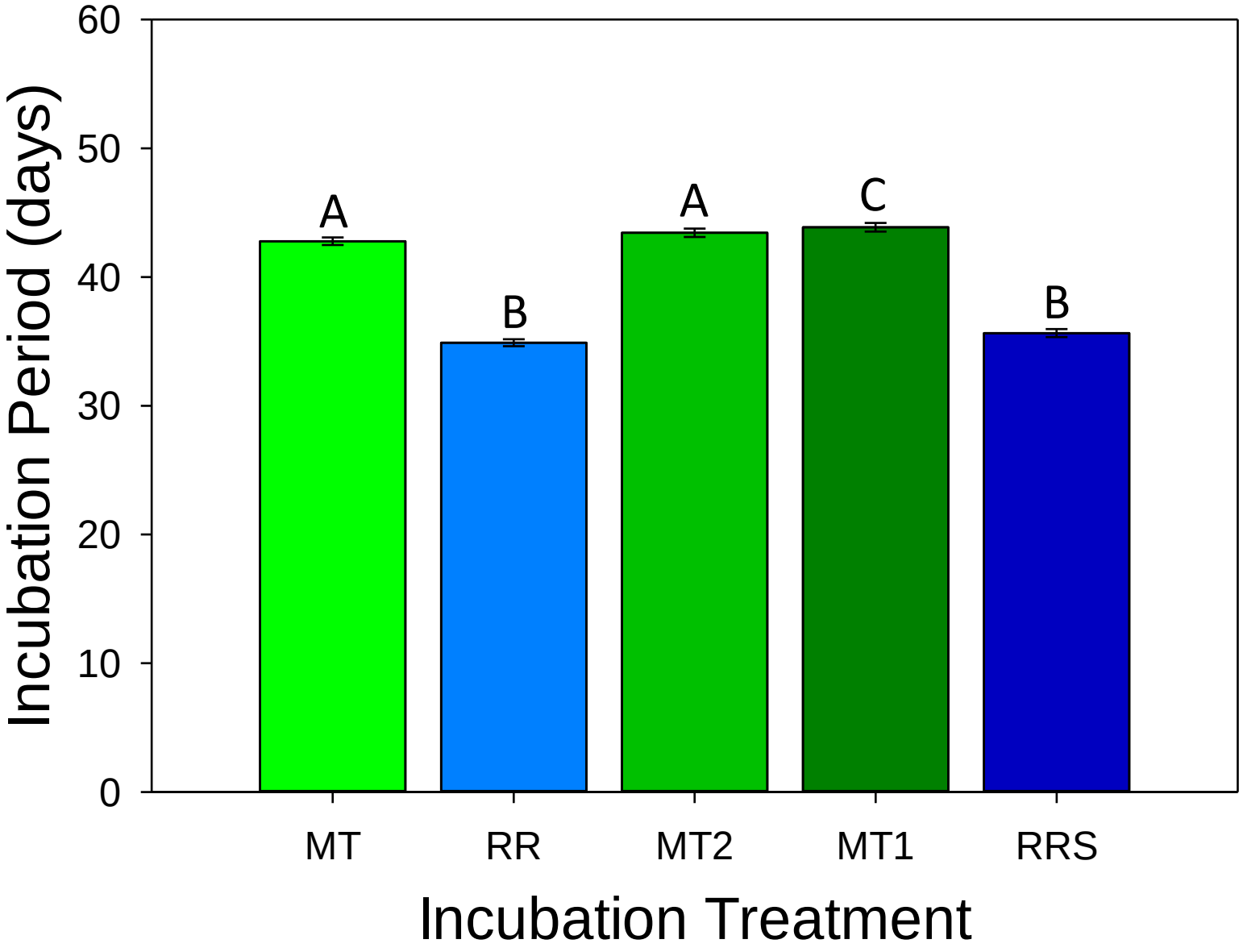
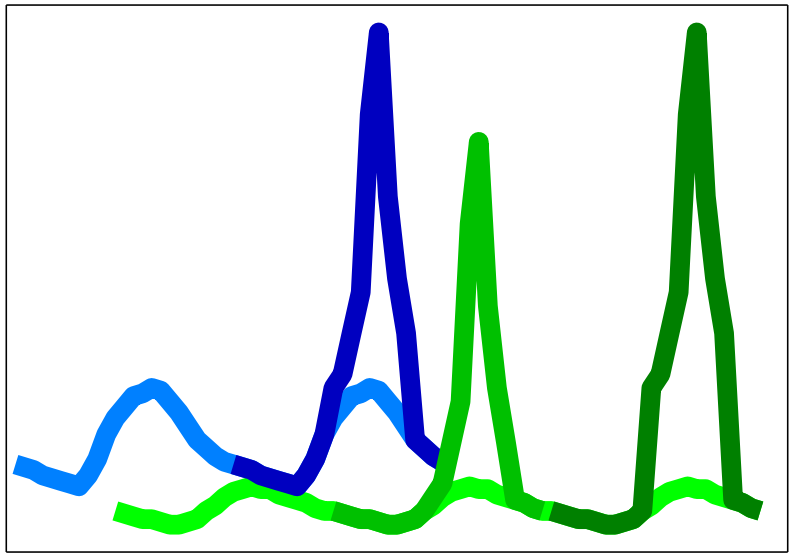
Incubation Period





Urban background regimes shorten incubation period

Potential Site x Treatment Interaction