Freezing and Recovery Time of Red Flour Beetles

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Abstract

Body size plays a critical role in animal survival. In fact, Bergmann's Rule states that larger animals should be more successful in colder environments (McNab 1971), although this may not be the case for ectotherms like insects (see Mousseau 1997). The underlying mechanism for this relationship is that larger animals have lower surface to volume ratios, thus making freezing more difficult (Schmidt-Nielsen 1984). So we tested the hypothesis on Red Flour Beetles to see if it holds for very small organisms. We found that hypothesis is supported by the experiment.

Purpose

The purpose of this research is to determine if there is difference of freezing and recovery time for small volume creatures.

Questions, Hypotheses, and Predictions

Question: Does volume small as beetles get impacted on freezing and recovery time?

Hypothesis: Yes, volume has affect on small creatures like red flower beetles

Prediction: There will be more large red flour beetle that survived

Study System

I used three different sizes of Red Flour Beetles for this experiment. The small size (Z-2 strain) is 0.9cm by 3cm; the medium size (KC strain) is 1cm by 4cm; the large size (Goliath strain) is 1.5cm by 5cm. Also, all the beetles we used were maintained in Dr. Philips's lab on a 14:10 light cycle at 29C .
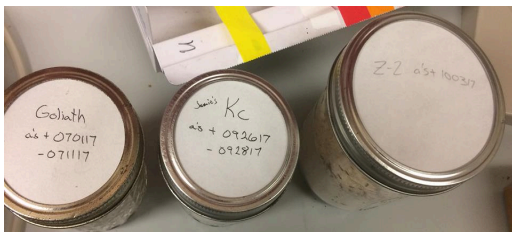
Methods and Experimental Design

For this experiment, I used three different sizes of Red Flour Beetles to test my hypothesis. I put five beetles into every small glass veils and I used three small glass veils for every group: 5 minutes, 10 minutes, and 20 minutes. After that, I put them into the freezer (-19C) and wait for the time according to the group. As the time is up, I remove the beetles from the freezer and place them at room temperature (30C). I record the beetles' survival rate every minute for ten minutes.

Results

5 minutes   10 minutes   20 minutes
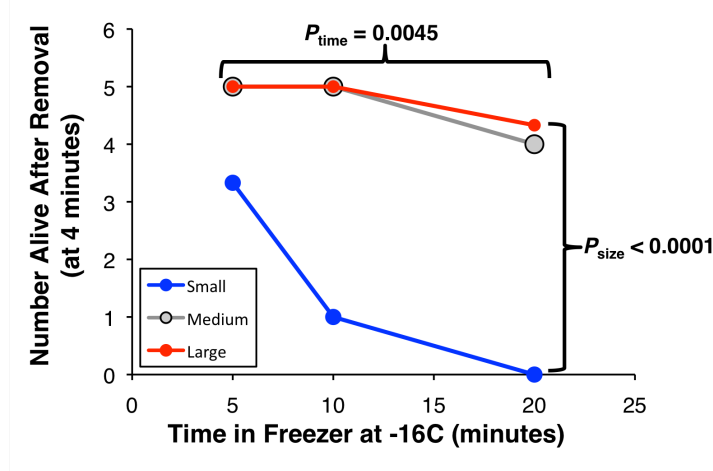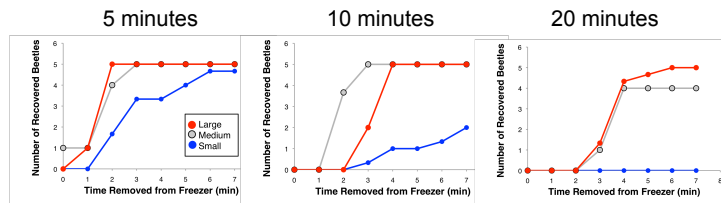
	Volume (cm^3)	Area (cm^2)	A/V
L	10.6	34.17	3.22
M	3.7	17.28	4.71
S	2.3	12.30	5.37

Cylinder

$$V = \pi r^2 h \qquad A = 2\pi rh + 2\pi r^2$$

Sphere

$$V = \frac{4}{3}\pi r^3 \qquad A = 4\pi r^2$$

Conclusions

Although there weren't a big different between the large and medium size beetles, but the small and medium size have a dramatic change between he two.

Future Directions

If the research is continued, I think the next step will be testing with different lines of beetles. Since the three different sized beetles we used are from the same line, which can have some affect on the result. Also, I can adjust the temperature as another variation, by doing this, I can find out the how cold they can survive, how dramatic temperature change can impact them and so on.

References

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Schmidt-Nielsen, K. 1984. Scaling: why is animal size so important? Cambridge University Press.

Acknowledgements