Eat while it's hot:

Callosobrascus maculatus bean consumption over different temperatures, related to the Metabolic Theory of Ecology

Banshoya A. Y. I, Berheim L. R. J-M, Eriksen J. H. F, Haring V, Kuhle J, Thorsen M. A

Background

- The Metabolic Theory of Ecology links the metabolic rate of an organism to the organism's mass and temperature:

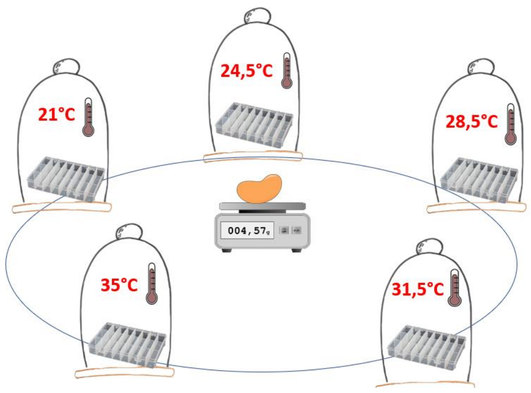
$$I = i_0 M^{\frac{3}{4}} e^{-\frac{E}{kT}} \qquad [1]$$

- Consumption is an important metabolic process.
- Our model organism, *C. maculatus,* only eats in the larvae stage [2]. The consumption can be measured by weighing beans before and after emergence.
- In this study we investigate the larvae's bean consumption in different temperatures.
- We compare our results to models presented by Arroyo et.al [1] and Gilloy et.al [3]

Hypothesis

The consumption is expected to follow the Arroyo et al. model; An increased temperature = increased metabolic rate. Once the temperature passes the optimum, we expect to see a steep decline in the metabolic rate.

Experimental design



- Petri dish with black-eyed peas, and added male and female to produce eggs
- We selected beans with one egg
- Weighed before and after the emergence
- We calculated the difference: $\Delta=W_i-W_f$
- RStudio

Results

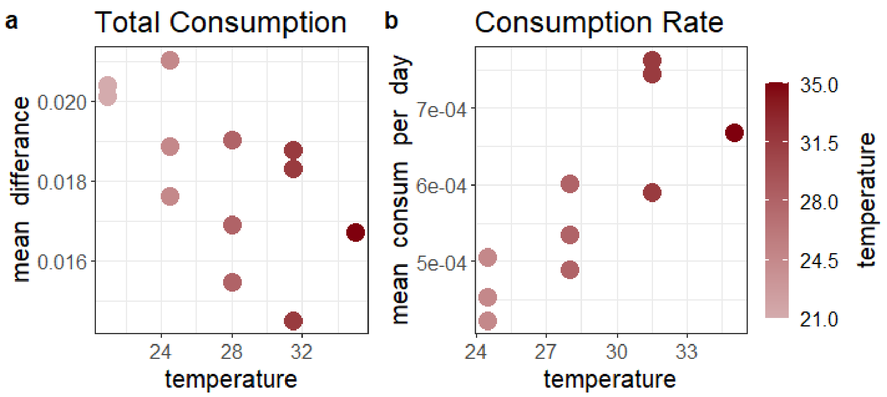


Fig1: a: Mean weight difference of one bean per temperature. b: Consumption rate is bean weight divided by days from the start of the experiment to beetle emergence.

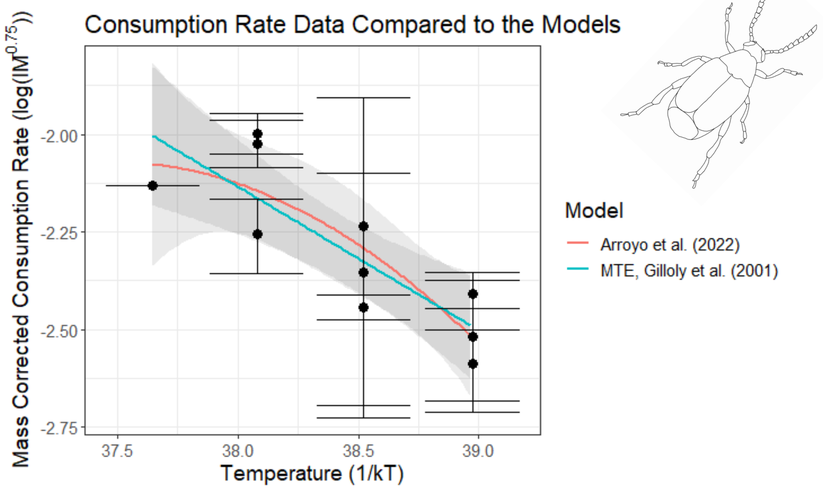


Fig2: Mass corrected consumption rate in relation to Arroyo's (red) and Gilloy's model (blue). Both models are statistically significant for a significant level at .05.

Discussion

- We believe the colder temperatures resulted in a longer larvae stadium, and therefore more of the bean was consumed.
- When corrected for larvae stage length, we get the consumption rate. We see that the larvae in warmer temperatures eat more per day.
- Mentioned in the Whitfield J. paper, the model is not necessarily fitting for each ecological process [4].
- Due to the lack of data, a removal of the outliers was not possible, which led to a high standard deviation. The setup of the experiment design was not fitting our study.

Conclusion:

Our results did not fit with The Metabolic Theory of Ecology. Further research should be done to see if it is due to our experimental design, or if the consumption rate could not be predicted by this model in this specific case.

References:

[1] Arroyo et al. (2022) A general theory for temperature dependence in biology. *Proceedings of the National Academy of Sciences* 119:30, e2119872119. https//www.pnas.org/doi/abs/10.1073/pnas.2119872119.

[2] Beck C. W., and Blumer L. S., (2014) A Handbook on Bean Beetles, Callosobruchus maculatus. National Science Foundation.

[3] Gilloly et al. (2001) Effects of Size and Temperature on Metabolic Rate. *Science*, 293,2248-2251 doi:10.1126/science.1061967.

[4] Whitfield J (2004) Ecology's big, hot idea. PLOS Biology 2:12: e440. https://doi.org/10.1371/journal.pbio.0020440.