

HOW IS REPRODUCTION AND SURVIVAL RATE AFFECTED BY TEMPERATURE AND RESOURCE AVAILABILITY?



BIO201: GROUP 2
FRANCISCO, IDA, INGRID, MAJA, MAGNUS, MARKUS



Universitetet i Bergen

Hypothesis: The bean beetles will have a higher survival rate and reproductive success at higher temperatures up to a certain limit, and will compete for resources at the larval stage, such that fewer beans limit their survival rate.

INTRODUCTION

Bean beetles exclusively feed on beans. The adults lay eggs on the surface for larvae to feed from the inside until they mature and emerge. In the adult stage they neither drink nor eat.

Metabolic theory of a ecology predicts how metabolic rate controls most observed patterns in ecology (Brown et al. 2004). Based on measuring a series of metabolic reactions, the mean activation energy for all metabolic reactions is 0.62 eV.

One important factor influencing metabolic rate is temperature. Theoretically higher temperatures should speed up chemical processes.

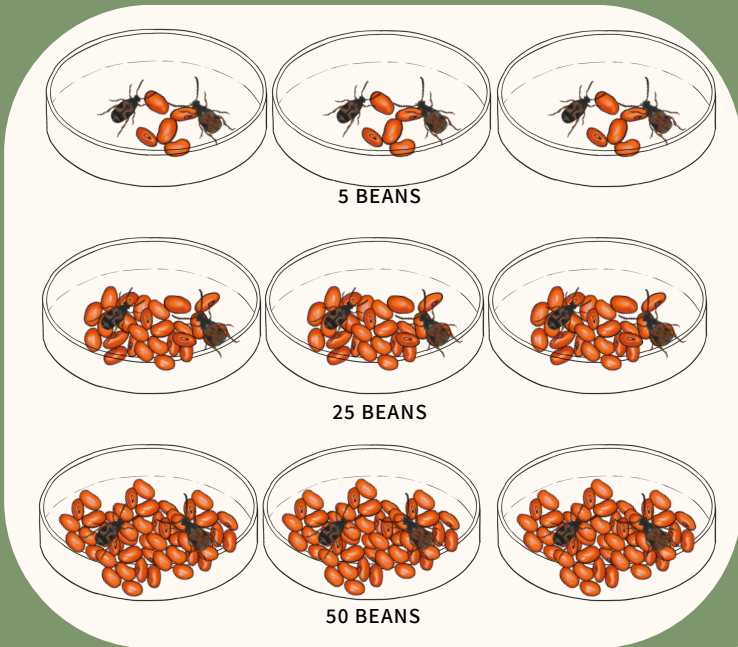
Competition is a negative interaction occurring among individuals feeding on the same resources. Generally scarcity of resources is known to increase competition.

AIM: Understanding the relation between metabolic rate and competition and reproductive ability for bean beetles

METHOD

EXPERIMENTAL SETUP:
SETUP AS SEEN IN FIGURE, DUPLICATED FOR FIVE DIFFERENT TEMPERATURES; 21°C, 26°C, 29°C, 32°C AND 35°C

- Method:**
1. Set up of experiment, as seen in figure.
 2. After 46 days, we counted the eggs laid on the beans by the beetle in each petri dish and noted this
 3. After 15 more days, we counted the beetles emerged from the eggs in each petri dish, and noted this.
 4. We used R for statistical analysis of the data.



Survival rate of *Callosobruchus maculatus* dependent on no. beans and temperature

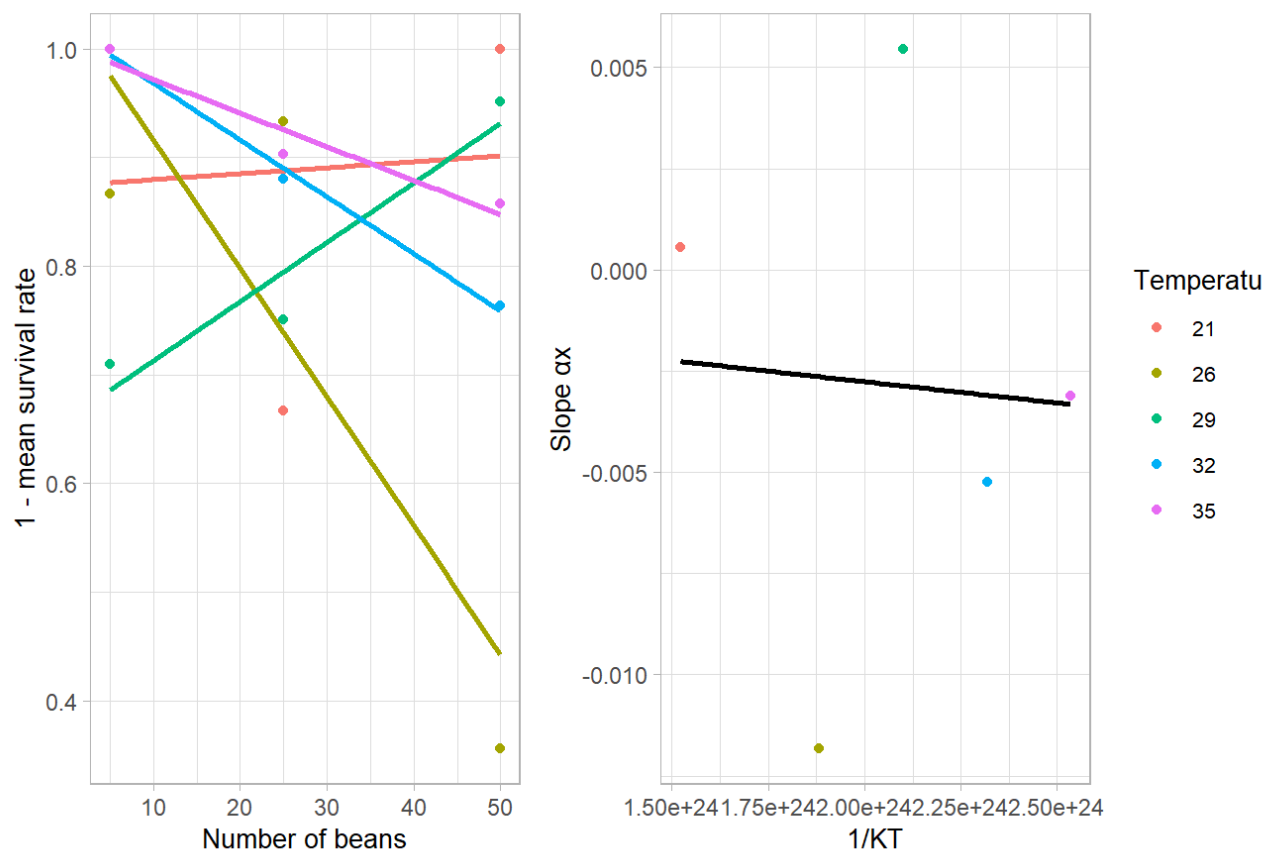


Figure 1: Survival rate of bean beetles in relation to bean quantity across various temperatures. Left: Survival rates for different bean quantities at five temperatures. Right: Slopes derived from the linear models at these temperatures, over 1/KT, where K is the Boltzmann constant and T is temperature in Celsius. The regression slope is estimated to -1.045e-27.

Eggs laid based on female mass at different temperatures

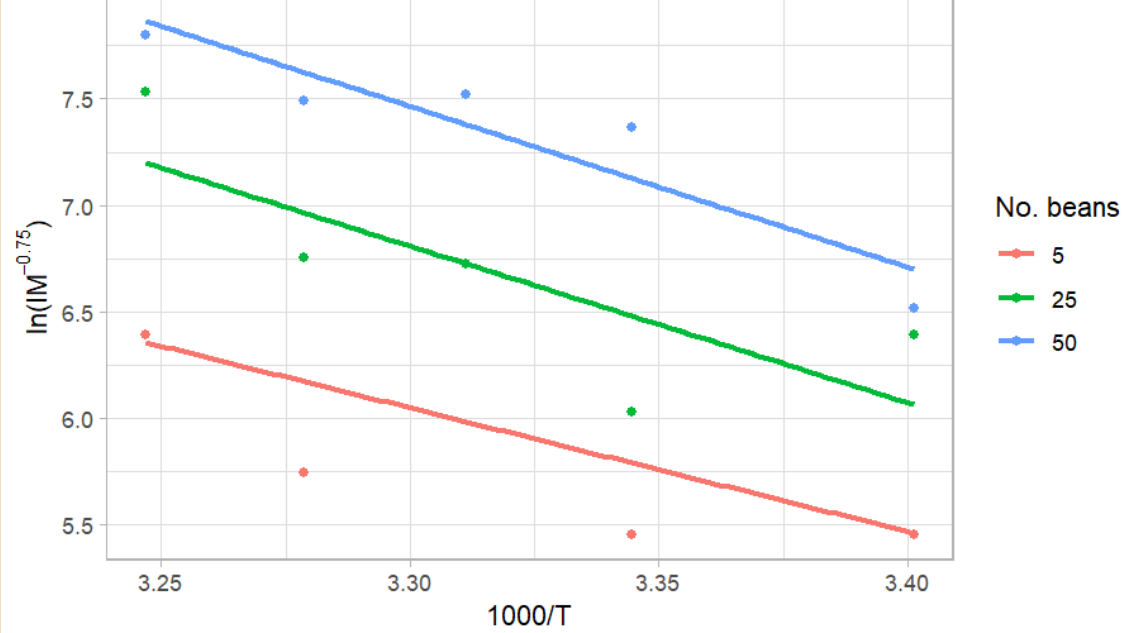


Figure 2: Effect of temperature on mass-normalized egg laying rate at different quantities of beans; 5, 25 and 50. The slopes are estimated to -5.80, -7.35 and -7.55 respectively.

Table 1: The slope of the effect of temperature on mass-normalized egg laying rate, corrected from joules to electron volts.

No. beans	Slope (eV)
5	0,50
25	0,63
50	0,65

RESULTS

- Higher temperatures causes the beetles to lay more eggs according to fig. 3
- There is correlation between the number of beans and number of eggs laid.
- A higher amount of beans causes the beetles to lay more eggs.
- Little correlation between number of beans and survival of eggs (fig 1.) and no correlation between survival and temperature.

CONCLUSION

Our result fits with the prediction from metabolic rate theory, with an activation energy around 0,62eV. The exception is the set up with 5 beans which had a lower activation energy at 0,50eV, which might result from the smaller sample size, as fewer eggs were laid at this number of beans. Our experiment suggests that temperature and number of beans has a large effect on number of eggs laid, but no effect on the survival rate of the hatched beetles, contrary to the hypothesis. There is no clear correlation between the number of beans and survival rate, suggesting that competition had no effect

References:
1: Brown, J.H., Gillooly, J.F., Allen, A.P., Savage, V.M. and West, G.B. (2004), TOWARD A METABOLIC THEORY OF ECOLOGY. Ecology, 85: 1771-1789. <https://doi.org/10.1890/03-9000>
2: James F. Gillooly et al. Effects of Size and Temperature on Metabolic Rate. Science 293, 2248-2251 (2001). DOI:10.1126/science.1061967