Does caffeine lead to cannibalism? A test in *Tenebrio molitor*

Adam Curry and Renee Rosier

What is caffeine?

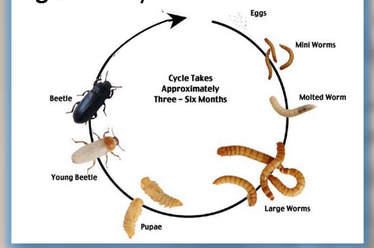
- Caffeine is a stimulant for humans,[1] boosts memory in bees at low doses,[2] reduces reproduction in butterflies,[3] and is also a natural insecticide.[4]
- Caffeine is increasingly common in the environment through human-produced wastes, such as in compost heaps.
- The darkling beetle (*Tenebrio molitor*) is commonly found in compost and will resort to cannibalism to meet energy and nutritional needs (Fig 1).

→ Caffeine = higher metabolic rate = greater nutritional needs = more cannibalism?

Does exposure to caffeine reduce fitness of *T. molitor*?

Does exposure to caffeine increase rates of cannibalism in *T. molitor*?

Fig 2: Life cycle of *T. molitor*



Methods

- Beetle colonies were maintained in either Control (0% caffeine) or Caffeine (5% coffee grounds) substrates
- Number of adults, pupae, and larvae were counted each week (Fig 2)
- Evidence of cannibalism was noted each week
- Statistical analyses were conducted using JMP Pro 12

Results

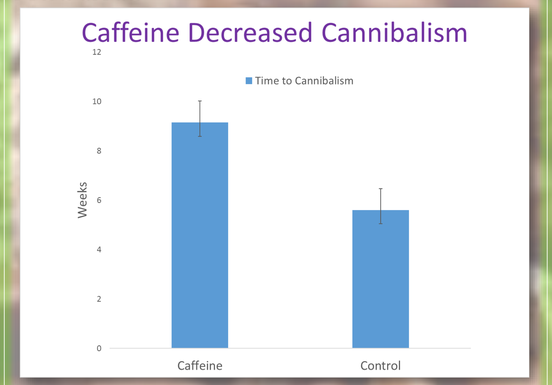


Fig 7: Time until cannibalism was detected. Bars represent averages ± 1SE. ($\chi_{1,15}$ = 7.18, p = 0.0074)

Fig 1: Two mature adults consuming the entire abdomen of a young adult.

Results

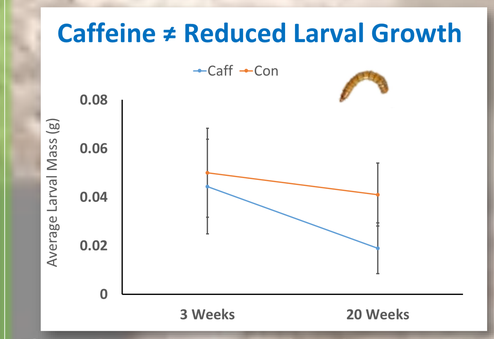


Fig 3: Change in average larval mass ± 1SE. ($F_{1,10}$ = 0.34, p = 0.57)

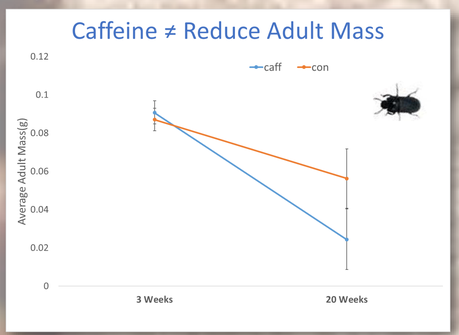


Fig 4: Change in average adult mass ± 1SE. ($F_{1,6}$ = 0.32, p = 0.59)

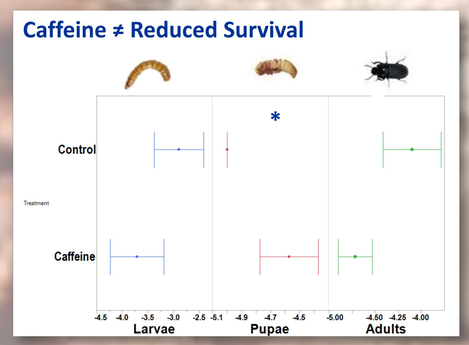


Fig 5: Change in number of individuals ± 1SE. (Larvae: $F_{1,15}$ = 1.27, p = 0.28, Pupae: $F_{1,15}$ = 6.62, p = 0.02, Adults: $F_{1,15}$ = 2.26, p = 0.15)

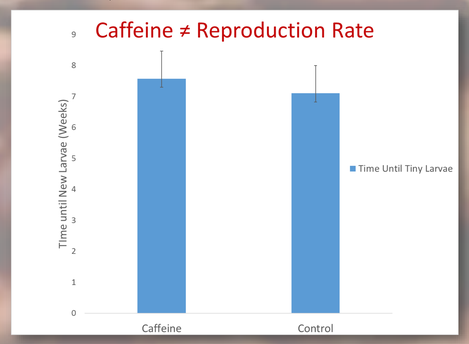


Fig 6: Time until newly-hatched larvae were detected, indicating successful reproduction. Bars represent averages ± 1SE. ($\chi_{1,15}$ = 0.13, p = 0.72)

Discussion

- Caffeine exposure did not reduce growth, survival, or reproductive success of *T. molitor*; however, caffeine did significantly improve survival of pupae (Fig 5). Since pupae are immobile they are defenseless they are more likely to be cannibalized. The higher rate of cannibalism may have led to the decreased survival of pupae in the Control treatment.
- The reduced rate of cannibalism in Caffeine treatments could be due to reduced feeding rates overall.[5]
- This study is ongoing to investigate the longterm effects of caffeine exposure.

Acknowledgements and References

[1]Rall (1980) Pharmacological Basis of Therapeutics, AG Gilman, L Goodman, A gilman Eds. Macmillan, New York.
[2] Chittka & Peng (2013) Science. 339:1157-1159
[3]Mathavan, Premalatha & Christopher (1985) Experimental Biology. 44:133-138
[4] Nathanson (1984) Science. 226:184-187
[5] Gavrieli, Karfopoulou, Kardatou, Spyreli, Fragopoulou, Mantzoros & Yannakoulia (2013) Obesity. 21:1127-1132.

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