

Social Behavior in Groups of Mating Male and Female Bean Beetles

Britney M.D. Howard, Aysha F. Rahman, and Barbara Musolf
Department of Natural Sciences, Clayton State University, Morrow, GA 30260

Introduction

Callosobruchus maculatus, commonly called the cowpea weevil or bean beetle, is a common agricultural pest that preys on legumes (Tran and Credland 1995). Few studies exist concerning the social behaviors in *C. maculatus*. Previous studies in our lab indicated that male *C. Maculatus* placed in a maze showed no preference for the odors produced by male or female beetles. As a result, it was not clear whether male *C. maculatus* were clearly discriminating between the two sexes. The purpose of this experiment was to investigate male bean beetles' social behavior to determine whether they behave differently towards the two sexes.

Adult bean beetles are storage pests and, as such, are found in large numbers on stored beans. A single bean, such as *Vigna vulgaris* (black-eyed pea), can support as many as four or five beetles at a time. The adult emerges from the bean and reaches maturation 24 to 36 hours later, at which point male bean beetles begin to initiate mating behaviors (Blumer and Beck 2014).

Methods

We obtained 3 virgin male and 3 virgin female *C. maculatus* within 48 hours of emergence. We utilized brightly colored paint pens to paint the abdomen and backs of each of 6 of the beetles so we could identify and differentiate between the beetles for video analysis. We then placed the six beetles in a 250mL petri dish together. We recorded the behaviors for twelve hours. However, we only used the first four hours of recording to evaluate mating and other social behaviors such as antennation, wrestling, and mounting. We then ranked the males based on time spent in mating and aggression. We proceeded to construct ethograms on mating and other social behaviors.

Results

Males spend more time mating than in aggressive behavior toward each other

Mating Time (sec)

Trial	Male 1	Male 2	Male 3
Trial 1	1505	0	0
Trial 2	698	356	546
Trial 3	1290	0	0
Trial 4	1863	610	0
Trial 5	679	34	0

Table 1: Rank 1 males spend more time mating than other males.

Aggression Time (sec)

Trial	Male 1	Male 2	Male 3
Trial 1	82	0	0
Trial 2	114	268	30
Trial 3	0	0	0
Trial 4	17	94	0
Trial 5	0	0	0

Table 2: More aggression is found in unsettled groups that have ambiguous Rank 1 males.

Males form a dominance hierarchy with one superdominant male

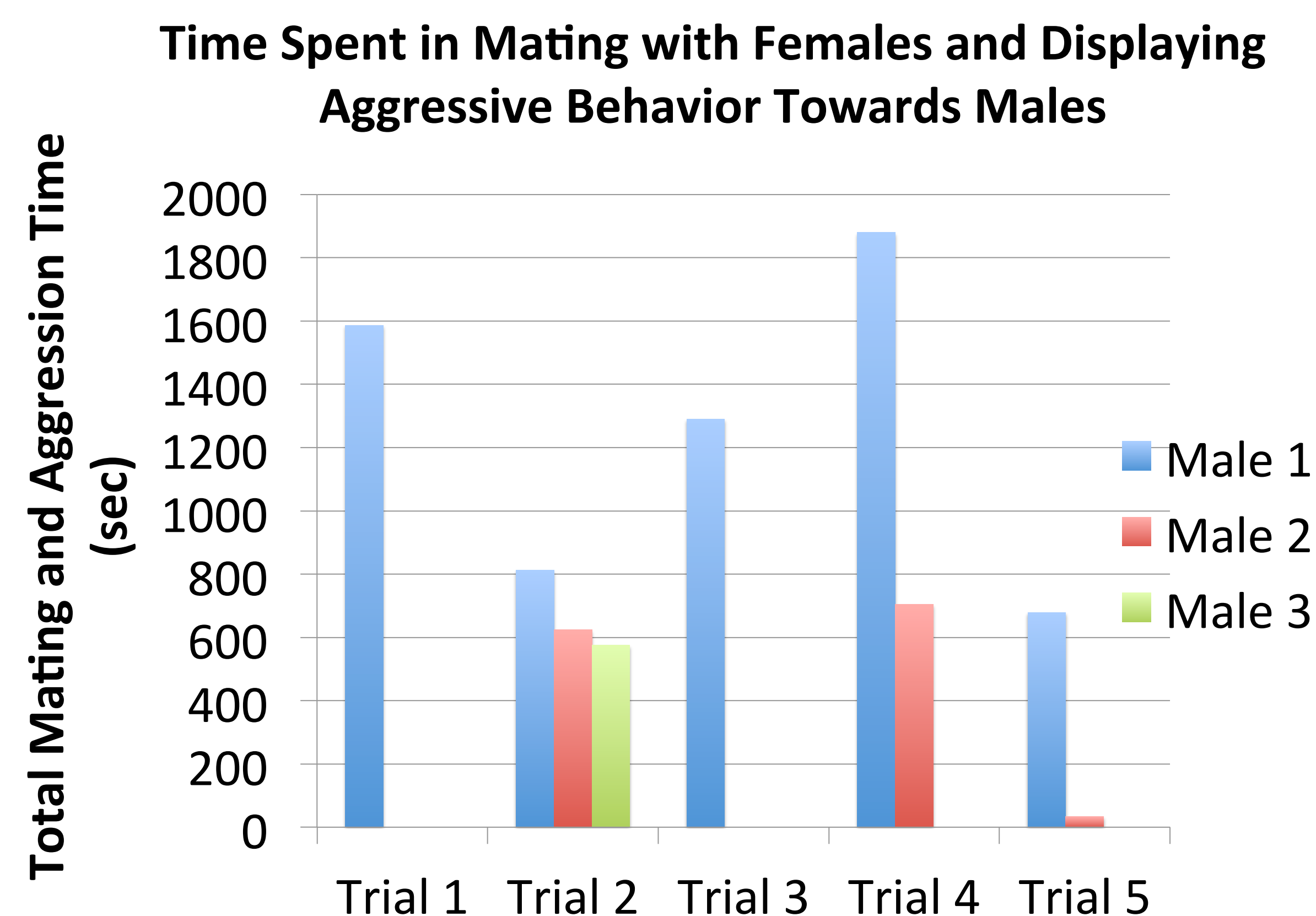


Fig. 1: Males were ranked based on the amount of time spent in both mating and aggression, where Male 1 ranked highest, Male 2 second highest, and Male 3 lowest, typically showing no mating or aggressive behaviors.

Escalation of Aggressive Behavior

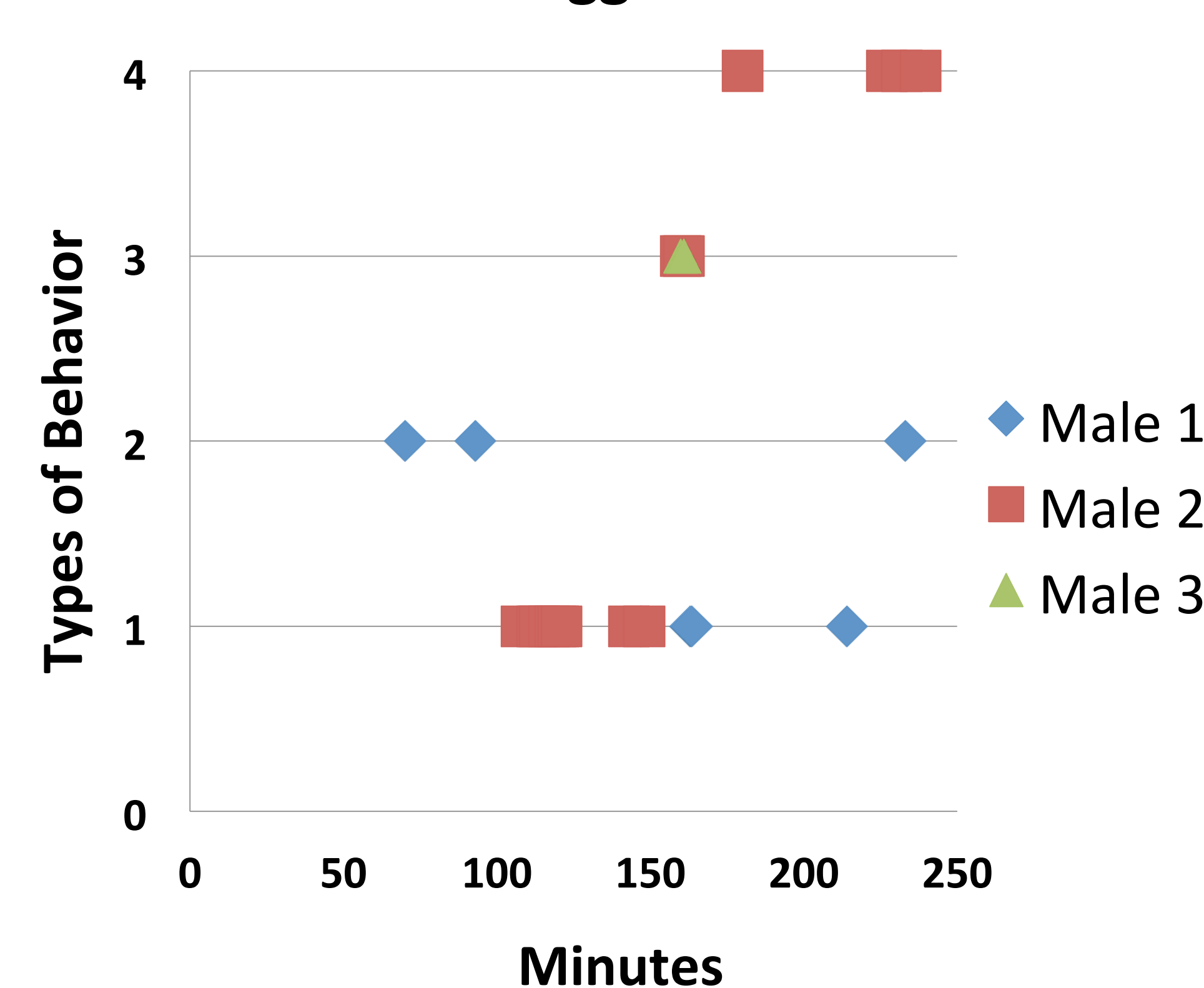


Fig. 2: In Trial 2, the group that contained ambiguous Rank 1 males, more instances of aggression were shown, and the scale of the aggressive behaviors escalated over time. Behavior 1 = antennation, 2 = mounting, 3 = wrestling, and 4 = climbing onto the back of another beetle.

Conclusions

- Males spent more time mating with females than in interactions with one another.
- In most groups, males formed a dominance hierarchy with a superdominant male.
- The one group that had no superdominant male spent more time in aggressive behavior against other males than in other groups.
- In the one group that did not form a dominance hierarchy, aggression escalated from mounting and antennation to wrestling and standing on the back of another male beetle.

The formation of dominance hierarchies in seed beetles has not been documented before. Fighting behavior has been described among the grain beetle, *Tenebrio molitor*, but the formation of a dominance hierarchy was unclear (Howard 1955). The closest model we found for a dominance hierarchy formation was in juvenile crayfish, which form a dominance hierarchy headed by a superdominant male (Issa et al. 1999).

Future Directions

We plan to collect more data by running more trials using the methods described here. We will also weigh the different males to determine which one is the largest to see if size is correlated with superdominants as it is in crayfish (Issa et al. 1999) and in the grain beetle *Tenebrio molitor* (Howard 1955). Once we have more data on groups of 6 beetles, we will increase the number of beetles used in a trial to observe if dominance hierarchies are maintained in larger populations.

We would also like to see whether the presence of females affects male-to-male interaction, so we will run similar trials with the absence of females.

Acknowledgements

We would also like to thank Rocio Solomon for instructing us on how to identify the different stages of the beetles and how to build stock cultures.

References

- Blumer, Lawrence and Beck, Christopher. 2005-2014. A Handbook on Bean Beetles, *Callosobruchus maculatus*. <http://www.beanbeetles.org/handbook/> Retrieved March 26, 2014.
- Howard, Robert Stearns. 1955. The occurrence of fighting behavior in the grain beetle *Tenebrio molitor* with the possible formation of a dominance hierarchy. *Ecology* 36:2 281-285.
- Tran, B. M. D. and P. F. Credland. 1995. Consequences of inbreeding for the cowpea seed beetle, *Callosobruchus maculatus* (F.) (Coleoptera:Bruchidae). *Biological Journal of the Linnean Society*, 56, 483-503.
- Issa, F.A., Adamson, D.J., and Edwards, D.H. 1999. Dominance hierarchy formation in juvenile crayfish *Procambarus Clarkii*. *The Journal of Experimental Biology*, 202, 3497-3506.