Using Bean Beetles (*Callosobruchus maculatus*) in Guided Inquiry Exercises in the Biology Laboratory

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INTRODUCTION

Guided inquiry exercises in biology labs, in which the instructor provides a context for a scientific study and an overarching question, are good alternatives to exercises involving step-by-step lab manual instructions (NRC, 2003). Such an exercise parallels more closely the work done by a practicing scientist.

Within the instructor-provided context, the students write hypotheses, design and perform experiments, analyze data, and draw conclusions.

Due to various constraints, a "system" that students can manipulate -- for example, reproducing bean beetles -- is usually required.

Details about the culturing and life cycle of bean beetles are readily available at www.beanbeetle.org.

Overarching question: What factors influence the reproductive success of bean beetles?

EXAMPLE STUDENT HYPOTHESES

Beetles will live longer and lay more eggs at high relative humidity (RH) than low RH.

Beetles will live longer and lay more eggs when reared on blackeye peas (BEP) than on mung beans.

Beetle offspring will emerge sooner, and a greater fraction of eggs will result in emerged offspring, at high RH than low RH.

Beetle offspring will emerge sooner, and a greater fraction of eggs will result in emerged offspring, when reared on BEP than on mung beans.

MATERIALS NEEDED

Bean beetles (Carolina Biological Supply, Cat. No. 144180)

Blackeye peas and mung beans (grocery stores)

High and low RH insect incubators (Carolina Biological Supply, Cat. No. 173150) (high RH incubator includes 150 mm plastic Petri dish kept full of water)

Plastic Petri dishes, 60 mm x 15 mm, for holding beans and beetles

Hygrometers (available at electronics stores and home stores)

Featherweight ("soft") forceps (Ward's Natural Science, Cat. No. 140520)

Dissecting microscope for examining beans for eggs

EXAMPLE STUDENT PROCEDURES

From an existing colony, place one-egg-bearing beans into small Petri dishes, one egg per dish.

Check the dishes daily. When a female beetle emerges from a bean, record her day of emergence, assign her a number, and add a male beetle from an existing colony to her dish. After the beetles have mated, remove the male and cover the bottom of the dish with a layer of either BEP or mung beans. Place half of these dishes in the high RH and half in the low RH incubator.

For each mated female, twice per week until she dies, count the number of eggs she lays. At each counting, remove any eggs (with their beans) into a separate small Petri dish labeled with the mother's identification number.

Examine the eggs laid by each female every other day, recording whether or not offspring have emerged from each of these eggs and, if so, how many days elapsed between mating of the mother and emergence of her offspring.

Record the day on which each female dies.

EXAMPLE STUDENT DATA

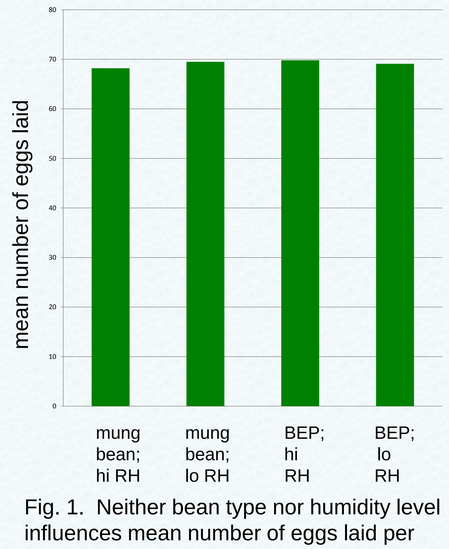

Fig. 1. Neither bean type nor humidity level influences mean number of eggs laid per female.

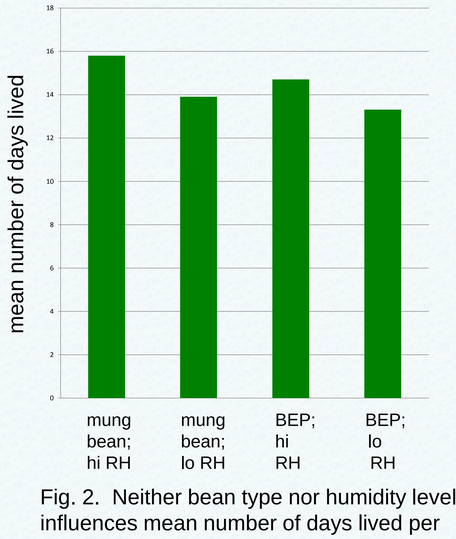

Fig. 2. Neither bean type nor humidity level influences mean number of days lived per female.

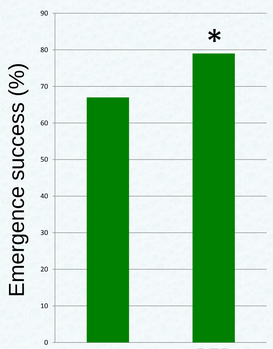

Fig. 3. The proportion of eggs resulting in successfully emerged offspring is greater on BEP than on mung beans (both at high RH).
* = significantly different at $p < 0.05$.

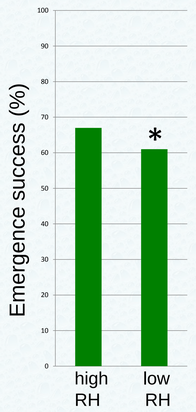

Fig. 4. The proportion of eggs resulting in successfully emerged offspring is greater at high RH than low RH (data from mung beans only).
* = significantly different at $p < 0.05$.

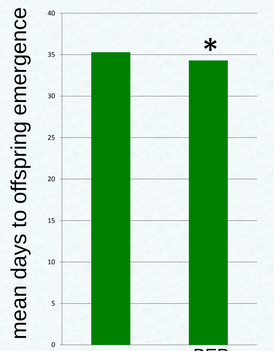

Fig. 5. The time required for offspring to emerge is significantly shorter in BEP than in mung beans (both at high RH).
* = significantly different at $p < 0.05$.

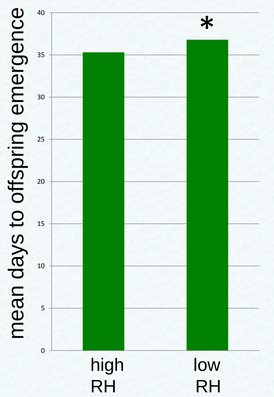

Fig. 6. The time required for offspring to emerge is significantly shorter at high RH than low RH (data from mung beans only).
* = significantly different at $p < 0.05$.

LITERATURE CITED

National Research Council [US] Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century; Bio2010: Transforming Undergraduate Education for Future Research Biologists; National Academies Press [US], Washington DC, 2003