

Rapid Adaptation of Bean Beetles to a Novel Host

Instructor's Notes

Consult the [Laboratory Methods](#) section of the Bean Beetles website for detailed information on growing cultures and handling techniques, as well as tips on identifying the sexes.

The experiment requires having dense cultures of bean beetles from which females can be isolated. Beetles should be from cultures reared on a natal host and from cultures switched to a new host several generations prior to the experiment. If new cultures are initiated approximately 2 months before the lab period, there will be sufficient time for two generations of beetles, which will result in dense cultures. When possible, we supply one culture of each type (natal and new host) to each group of students working in pairs. However, each culture should have sufficient beetles for use by multiple student groups. Sufficient cultures for one class section can be established in less than an hour. Once cultures are established, they do not need to be monitored or recultured until 2 months later.

Experimental Design

Students often design reciprocal transplant experiments in which females from each host lay eggs on their natal host or an alternative host. However, students may have difficulty determining what dependent variables to measure. Time to emergence, body size at emergence, and emergence success can be measured in a reasonable time span. Students may suggest other offspring characteristics, such as lifespan, reproductive success, hatching rate, and sex ratio. Characters such as lifespan could be measured, but would add another two or more weeks to the experiment. Other dependent variables are appropriate, but difficult to measure (i.e., reproductive success and hatching rate). Finally, for other offspring traits like sex ratio, the predictions are not clear. Each student should set up a single replicate of each treatment combination of the reciprocal transplant experiment. To set up a replicate, a single female from a stock culture (either mung or adzuki/BEP) is added to a 35mm Petri dish with a monolayer of beans (either mung or adzuki/BEP). Oviposition will readily occur during a 48-hour period. Although most adult females in an active culture will have been inseminated, some females may have only recently emerged (and be infertile) and others are near the end of their adult life (and laid most of their eggs). Replication in the class will allow for failures in egg laying.

Data Collection

For offspring life history traits, one of the biggest confounding factors is the number of eggs laid on beans. If more than one egg is laid on a bean, then the larvae may compete for resources. As a result, only beans with single eggs should be used in tabulating data. Students may want to record the identity of the female that laid the egg to be able to consider differences among females in their analysis. However, data on female identity is not essential. Students can isolate beans of each species with single eggs into the wells of tissue culture plates or small Petri dishes. As the beetles emerge, students can record the offspring characteristics that they chose to measure. Accurate data on time to emergence and mass at emergence require that students check for emergence on a daily basis. As a result, measuring these life history traits may be feasible only in smaller, more advanced classes. The daily checks take between 15 – 30 minutes depending on the number of beetles that have emerged on that day. Students carry out

these checks outside of class time. Emergence success could be determined on a single day (potentially as a 1 hour part of a longer lab period) after sufficient time for emergence (approximately 40 days). Therefore, emergence success is more tractable for larger classes.

Data Analysis

Because the experiment is a 2 x 2 factorial design, the data are most appropriately analyzed with a multifactor ANOVA, assuming a normal distribution, which is commonly the case. If adaptation has occurred, we would expect a significant interaction effect between maternal host and offspring host, with offspring having higher fitness on the same host as their mother. In bean beetles, some life history traits differ between the sexes. Therefore, the analysis should be done for males and female separately. Students also could look at correlations between life history traits.