A Simulated Pollination Exercise

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It is generally not clear from general biology texts, or from popular videos on the subject, why certain flowers require a very specific animal to carry its pollen from one plant to another. This exercise is a simulation of pollination where conditions are set up such that a specific association benefits both the flower and the pollinator. There are some parallels between this exercise and the natural world.

In this exercise, there are four or five simulated flower types identified by color. There are four animal pollinators, identified as bee, fly, beetle, and wasp. Students play the part of a flower or pollinator. "Nectar" consists of four different colors of M&M's, and "pollen" consists of similar colored pieces of wood (about 3 mm square). One of the types of flower can be pollinated ONLY by the wasp, but the other three flowers can be pollinated by any of the insects. This information is not available to all the students before the experiment, but each "flower" is given secret instructions to allow or prohibit a particular pollinator. When a pollinator is allowed to land on a flower, it must deposit a randomly selected pollen grain on the flower, and it must also take a pollen grain from that flower. The pollinator also takes some nectar; specific pollinators get a little more nectar from their specific flower.

Three measurements are taken. First, the total number of trips is recorded for each pollinator to fill up its bin with nectar. Second, for each type of flower the total number of compatible pollen grains received is recorded. Third, the ratio of nectar given out to the pollinator per amount of compatible pollen received is recorded. In these simulations, the

specific pollinator fills up its bin faster than the non-specific pollinators. The flowers that require a specific pollinator give out less nectar per compatible pollen grain received, even though for each visit they give out more nectar than the general pollinators.

Students are then reminded about a typical temperate plant life cycle—that plants may burst into bloom in large numbers, but often for only a brief period during the year. Students are then asked to develop a simulation where general pollinators such as the honeybee have an advantage over a specific pollinator.

Instructions to Students

I generally tell the students as little as possible at first. I do not want them to know who the specific flowers or pollinators are, nor do I want them to expect a particular outcome before the simulation. Instruct the students carefully so that they take the exercise seriously; otherwise, some may make up their own rules.

General Flower Instructions

1. Don't eat the M&M's! You'll get some to eat at the end of the exercise. This is your nectar.
2. Accept ANY pollinator.
3. First, demand ONE randomly selected pollen grain from the pollinator, before he gets nectar – he will put the pollen grain on your stigma (the small hole in the small plastic bottle).
4. Then, give the pollinator ONE of your pollen grains from your anther (little beaker).
5. Lastly, for his services in transporting your pollen, give him nectar: ONE M&M.

Specific Flower Instructions

1. Don't eat the M&M's! You'll get some to eat at the end of the exercise. This is your nectar.
2. Accept ONLY the wasp (has the long forceps), but don't say why; just say, "GO AWAY" to all the other insects.
3. First, demand ONE randomly selected pollen grain from the pollinator, before he gets nectar – he will put the pollen grain on your stigma (the small hole in the small plastic bottle).
4. Then, give the pollinator ONE of your pollen grains from your anther (little beaker).
5. Lastly, for his services in transporting your pollen, give him TWO M&M's.

Insect Instructions

1. Don't eat the M&M's! and DON'T RUN!! --- Walk quickly to a flower and back to the colony to transport nectar (at the same time, you will inadvertently be transporting pollen).
2. If a flower ACCEPTS you, without looking (i.e., randomly) select one of the pollen grains in your bottle to deposit in the small hole on the "stigma"; THEN, pick up a pollen grain from the flower's anther (beaker).
3. After the pollen exchange, the flower will give you nectar, which you must immediately deliver it to the colony, before you can load up again on the next trip – i.e., You can carry only ONE load of nectar at a time.
4. The flower will determine how much nectar (M&M's) you can have.

5. If one of the flower types gives you more nectar, stick with it! (There are only two nectar reward levels in this simulation – high and low). The idea is to get a lot of nectar in as few trips as possible.
6. Some flowers may not accept you – "no" means NO! "GO AWAY" also means no! Go to another flower.

Materials

Flower:

Stigma -- Each consists of two parts, one where nectar is removed, and the other where pollen is deposited.

a. For supplying nectar I use a 6 inch plastic bottle with a 1.5 inch neck for the specific flower so that only the insect with tongs can remove the M & M's at the bottom. The other insects posses small forceps, which can be used to remove the M & M's (in 50 ml beakers) from any of the general flowers.
b. For receiving pollen, each of the flowers has a 50 ml bottle with a small hole in the top.

Anther -- All the flowers have a 50 ml beaker to supply "pollen grains" (about 50) to the pollinator.

Nectar: Pastel-colored M&M's -- blue, pink, green, and yellow.

Pollen grains: Wooden coffee stirring sticks, cut into squares, dyed (using clothes dye) the same color as the nectar so students know which flower they belong to; these were pilfered from the cafeteria.

Insect:

General insects have a small container like a microcentrifuge tube to hold pollen grains; I usually give them one initially, so they will be able to deposit something at the first flower (but this is not really necessary).

The general insect has a pair of forceps to remove an M&M from a beaker.

The specific insect has tongs to reach down into the bottle for the M&M's from the specific flower.

Hive: Some sort of container that holds 25-35 M&M's. When that is filled for all insects, the simulation is complete.

Collection of Data

Flowers record the total number of pollen grains given out, the total received, the number of same-colored pollen grains, and the total nectar given out. (You can do this by subtraction--e.g., start with 50 M&M's and see how many there were at the end.)

Each insect group (person at the hive) records the number of trips taken to fill up the nectar bin.