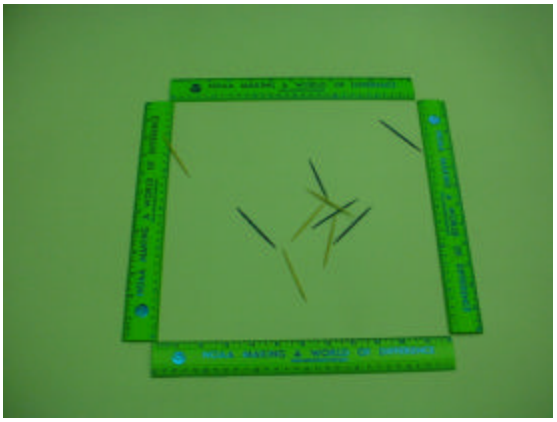
Broadcast Spawning in Corals: What are the Odds of Success?

Brain Coral spawning in Flower Garden Banks National Marine Sanctuary
Photo by: Emma Hickerson, Courtesy of the NOAA Photo Library

Focus Question:
Do corals gain some advantage by spawning all at once?

Background / Rationale:
Many organisms reproduce only in a limited season. In temperate climates, birds have young in spring, so that they are capable of migrating before winter arrives. In tropical climates some organisms only reproduce in the wet season, while others lay eggs only in the dry season. These patterns are specialized to aid the survival of each particular species. But reef building corals carry this pattern to an extreme, with nearly all the colonies on a reef spawning in a single night, and neighboring colonies spawning just a day or two before or after. Is this an advantage to the corals in some way? Is there a way we can test this pattern of reproduction statistically?



Materials needed:

- Approximately 50 toothpicks. Your teacher may suggest a similar item
- A separate area on the floor of between ¼ and 1 square meter. You may select certain tiles on the floor, or use a circle of string or square frame made with four rulers, as shown.

Student Activity:
Select an area of the floor (or outside, if your teacher suggests it) to do your experiment. Mark off the study area in the form of a square or better yet, a circle. You will be doing two series of trials, as described below. In both parts of the experiment, we are representing the potential reproduction of an equal number of coral colonies. In both parts, the same total number of gametes is released, but in the first part, the reproduction is spread out over five nights. In the second part, the reproduction occurs all in the same night.

Part 1:
The first series will represent spawning activity which is spread out over 5 nights. Scatter five of the toothpicks (or other objects suggested by your teacher) inside the study area. They represent five gametes (sperm or egg cells) that have been released by coral colonies into the water at one time. Stand back, and toss the toothpicks one at a time into the study area. Each time you toss a toothpick, record whether it strikes another toothpick or not, but leave it in the study area. Include any collision between any two toothpicks as a "fertilization," even though we would normally identify only collisions between a male and a female gamete. When you are finished, pick up the five toothpicks you tossed in, and repeat the experiment. Keep track of the total number of fertilizations (toothpick collisions) in each of your five trials by recording them in the table below. This represents the potential reproductive success of corals which spawn over a five night period.

Part 2:
In the second series, place 25 of the toothpicks inside the study area. These represent corals that all spawn on the same night. Then one at a time, toss the remaining 25 toothpicks into the area, leaving them where they land in the study area. Record the total number of times toothpicks collide in the table below.

Trial:	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total collisions
Part 1						
Part 2		X	X	X	X	

Analysis (You may need a separate sheet of paper):

1. Which part of the experiment yielded the greater number of collisions? Try to explain why the number of collisions was not equal.

2. If you repeated the experiment, would you expect exactly the same numbers? Explain why or why not.

3. Based on this model, which mode of reproduction would be more successful for the corals, reproduction in a single night or over a longer time?

4. This model suggests that coral gametes only survive in the water for a single night if they are unfertilized. How would results change if the gametes survived for a much longer period?

5. Like most simplified models, this is a little unrealistic. What are some factors in the natural environment which affect the success of coral reproduction which are not accounted for in our model?

6. In the real world, predators will be trying to eat as many of the gametes as possible. Which type of reproduction would be more successful if there is a predator in the area? Explain why you think so.

Conclusions:

What general conclusions can you make from this experimental simulation? You may wish to make a list, showing advantages and disadvantages of having all the corals in a reef spawn in the same night.

For Teachers:

Educational Objectives / National Science Standards supported by this lesson:
Strand A (Science as Inquiry), Strand C (Life Science)

Teaching time / Setting:
One period of 40 minutes to an hour may be needed to complete the lab, including follow-up questions. Additional discussion about predators and other factors may be helpful to students. Students will need a lot of space to lay out study areas. Unless the classroom is large or has a lot of open space, you may need to use a hallway, gym floor, or perhaps do the exercise outside. If the area chosen is small enough, desktops may provide a large enough space.

Suggestions:
In lieu of toothpicks, paper clips, or any small object that won't roll can be used. Coins can be used, but will roll or bounce outside the study area frequently. Loops of string can be measured and tied off ahead of time for the study areas, so that all students have an equal sized study area. Additionally, it is helpful to collect class data and encourage students to compare their own data with others in the class.

Analysis and Assessment:
The questions provided should provide a good basis for assessing students' understanding. In addition, you may wish to discuss concepts such as variability or repeatability of scientific data, and uncontrollable variables which create problems in field work (such as a school of fish which swims by, eating all the gametes they can hold).

Follow-up / Extension Activities:
This exercise can be used to introduce many discussion topics on the nature of scientific inquiry, such as sample size, experimental error, and variability in results. This experiment can be done using pennies with heads representing one sex gamete and tails the other, further making suggestions about reproductive success. In that case, only collisions resulting in one head and one tail would count as a fertilization. This should make results even more dramatic, and more realistic as well.

References and Internet Resources:
www.coralreef.noaa.gov This is NOAA's Coral Reef Home page, with access to photos and a variety of sites related to coral reefs.

http://www.reefs.org/library/article/coral_spawning.html An Article on coral spawning posted by the Reef Environmental Education Foundation. More links can be found from REEF's home page at www.reef.org.

http://www.gbrmpa.gov.au/corp_site/info_services/library/resources/reef_snapshots/coral_spawning.html An Australian site with photos of spawning corals.

http://www.coralreef.noaa.gov/ NOAA's Coral Reef online. Here you will find the latest news on coral reefs as well as links to the various NOAA web sites with additional information

http://www.coris.noaa.gov/about/welcome.html NOAA's Coral Reef Information System website about coral reefs.