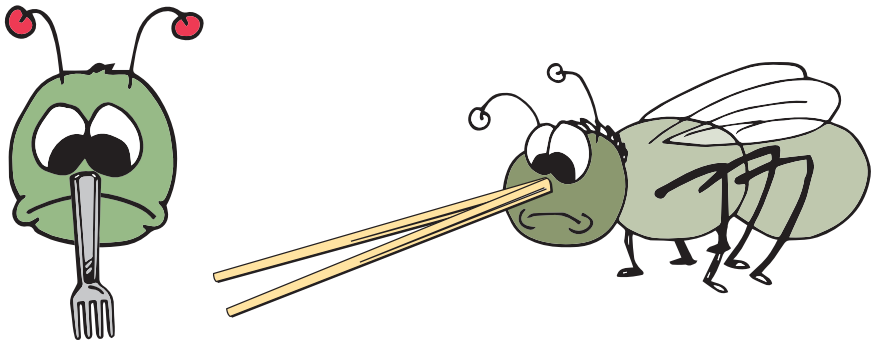
PLACER MOSQUITO & VECTOR CONTROL DISTRICT

HUNGRY BUGS

Evolution by Natural Selection



TOPICS

Environments, Ecology

MATERIALS LIST

For each activity station of 3 to 6 students:

- bag of white marshmallows
- box of nerds or other small pellet candy or nonpareils
- 2 felt sheets or similar clean fabric, 1 white and 1 black, 30 x 46 cm (12" x 18")
- 6 portion cups, 2 oz.
- 4 plastic forks
- 4 clothespins
- 3 straws
- 3 half sponges covered with double-sided tape
- 1 container
- Tape, clear
- 1 watch or timer
- Bug Evolution Table, page 4, 2 copies (a table for 4 players is available at www.raft.net/raft-idea?isid=648)

STANDARDS

Next Generation Science:

Life cycles (Grade 3, Life Science 1-1)

Traits of organisms (Grade 3, Life Science 3-1 & 3-2; Middle School, Life Science 4-4 & 4-6)

Characteristics & survival (Grade 3, Life Science 4-2 & 4-3)

Body structures (Grade 4, Life Science 1-1)

Ecosystems and populations (Middle School, Life Science 2-1 & 2-4; High School, Life Science 4-5)

National Selection (High School, Life Science 4-4)

WEB RESOURCES

https://curiosity.com/playlists/the-curiosity-of-animal-camouflage-HC7cmjMv/?utm_source=dsc&utm_medium=rdr&utm_campaign=rdrwork#intro-playlist

The Bug Chicks
http://thebugchicks.com/celestron/mandibles-part-one/

http://thebugchicks.com/celestron/insect-mouthparts-part-two/

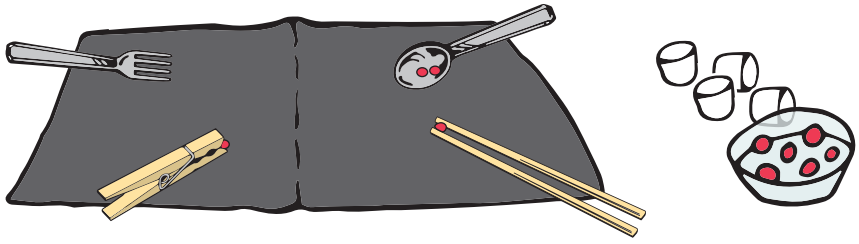
Insects exhibit a range of mouthparts, adapted to particular modes of feeding. The earliest insects had chewing mouthparts. Specialization has mostly been for piercing and sucking, although a range of specializations exist, as these modes of feeding have evolved a number of times. For example, mosquitoes, which are flies, and aphids, which are true bugs, both pierce and suck, however female mosquitoes feed on animal blood whereas aphids feed on plant fluids.

Insects have four general modes of eating: chewing, piercing and sucking, siphoning, and sponging. Examples of chewing insects include dragonflies, grasshoppers, and beetles. Siphoning insects include moths and butterflies. Piercing and sucking insects include aphids, leafhoppers, assassin bugs and female mosquitoes. The housefly is the typical sponging insect.

SIMULATE EVOLUTION WITH CRITTERS AND INSECTS

Simulate evolution with some colorful "food" and insects. Simulations are helpful to demonstrate processes like evolution that take place over many years. Observe how adaptations such as camouflage help organisms survive and pass on traits to offspring. Recognize evolution happening simultaneously in both the predator and prey (insect and critter) populations.

SET UP



RUNNING THE SIMULATION (3 TO 6 PLAYERS)

PLAYERS/ITEMS	ROLE
Students	Hunters (insects)
Felt Sheets/fabric	Habitat
Marshmallows and candy	Prey (critters)
Forks, straws, clothespins, taped/covered sponges	Mouthparts
Portion cups	Insect stomachs

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HUNGRY BUGS *Continued*

Figure 1

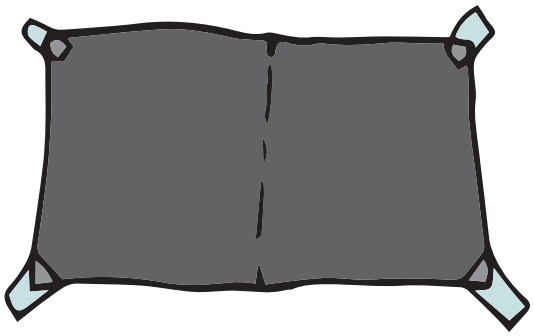

Figure 2

BEFORE THE ACTIVITY

1. Lay black habitat on floor or table. Tape corners to floor or table to prevent movement during use (see Figure 1).
2. Mouthparts Assignments: Each player (insects) uses one of the four mouthpart types (see Figure 2). If there are more than four insects, use a mouthpart type more than once. Record the starting mouthpart assignments in the Bug Evolution Table (page 4). Assign a timekeeper (part of the group or independent). Each player gets a portion cup for a stomach.
3. Carefully spread 60 critters (60 marshmallows only) evenly over the habitat.
4. Timekeeper begins Round 1 with a signal and the bugs quickly catch the critters and put them in their stomachs one at a time for 15 seconds using assigned mouthparts. Stomachs must be held in one hand and be off the habitat. Competition during simulation is acceptable and encouraged, but critters caught in other mouths become off limits to others. Critters "eaten" or off the habitat are considered dead and cannot be put back into the habitat.
5. When time expires, each bug counts his or her total number of critters eaten. Record the totals eaten per mouth type in the Bug Evolution Table in the row "Total critters eaten" for Round 1 (page 6). Which bug ate the most and which ate the least? Which birds ate the second-most and second-least?
6. The bug that ate the lowest number of critters has died. He or she is "reborn" with the mouthparts of the bug with the highest count and will use that mouth type in Round 2. For example, if the fork had the highest count at 27 critters while the spoon had the lowest count at only 15 critters, the spoon will be replaced by a fork in Round 2. The bug with the second lowest count acquires the mouthparts type of the bug with the second highest count. The bug with a middle count, if any, does not change mouthpart types. Record new mouthpart assignments for Round 2 in the Bug Evolution Table.
7. Repeat the simulation using the white habitat and new copies of the Bug Evolution Table.
8. Compare the data obtained from the white and black habitats. Discuss the results with the group and draw conclusions in terms of adaptation, inherited traits, fitness, and natural selection in both the hungry bugs and critter populations.
9. Repeat the simulation using the black habitat and 60 pieces of pellet candy and new copies of the Bug Evolution Table.
10. Compare the data obtained from the first round using marshmallows and the black habitat. Did different mouthparts work better for the pellet candy?

NOTE: *Remind students that natural selection is a mechanism of evolution that best explains change over time in organism populations. Natural selection is not synonymous with evolution, however, because there are several mechanisms at work that allow selection to take place.*

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TAKING IT FURTHER

- Continue simulation for additional generations
- Add more variation in mouthpart type and/or critter type.
- Use heavily-textured or patterned fabric in place of felt.

Extend this activity with the following suggestions:

- Design a predator best suited to a specific environment based on concepts learned from the simulation.
- Graph number of critters eaten vs. mouthpart type for each habitat color.
- Make a bar chart showing mean number of critters eaten for each type of critter for each habitat.

THE SCIENCE BEHIND THE ACTIVITY

Evolution by natural selection is a slow, gradual process that depends on three main factors: variation in characteristics, heritability of characteristics, and differences in fitness. Variation refers to different individuals in a population having different characteristics. For example, zebras have stripes but all will vary in terms of the shape, location, and pattern of their stripes. Characteristics passed on from parent to offspring are heritable characteristics, some of which make particular individuals in a population more likely to survive and reproduce than others. Fitness refers to an individual's ability to survive and produce offspring that are capable of reproducing. The particular characteristics that increase fitness will vary between populations and environments. Characteristics that increase an organism's fitness are called adaptations. When individuals in a population are fit they are more able to pass on adaptations to offspring as heritable characteristics and thus these characteristics become more common in the population.

A common misconception about evolution by natural selection is that it happens to an individual. Evolution by natural selection occurs due to changes in genetic make-up (allele and gene frequencies) within a population's gene pool that code for adaptations best suited for the environment. As gene frequencies gradually change in favor of adaptations over several generations, the favorable genes for the adaptations become more common. One explanation for this favorable shift is that less-fit individuals produce fewer offspring and contribute fewer genes into the gene pool. A declining gene pool contribution, coupled with predation, competition, and other environmental factors, can cause individuals with favorable adaptations to become more predominant in the population. In other words, evolution by natural selection happens at the population level, not the individual level.

This simulation provides a meaningful and simplified way to observe how evolution by natural selection operates in the real world. The food type and mouthparts type provide sources of variation to simulate favorable adaptations. Food that closely match the habitat color tend to be difficult to see, representing the adaptation of camouflage, which tends to increase fitness. One mouthpart type is typically more adapted to picking up certain foods and hence influences the mouthpart type passed on to future generations. The simulation explores two distinct but related lines of evolution by natural selection, survival in the critter population based on color and size, and survival in the insect population due to mouthpart type, which at first might seem unrelated. This activity illustrates some of the complex interactions between organism populations that biologists study and that also tend to perplex life science students.

WORKING WITH THE STUDENTS

It is important to talk about evolution as a theory and provide examples of the evidence supporting the theory in order to be sensitive to personal/family beliefs students may hold regarding the origins of organismal change over time. It may be beneficial to review the idea that science is a dynamic body of knowledge that is constantly refined as scientists learn more about the world. This helps to avoid uncomfortable situations where a student's personal beliefs regarding the origins of life and agents of change are challenged. Incorporating material on the history of scientific discovery might also be helpful.

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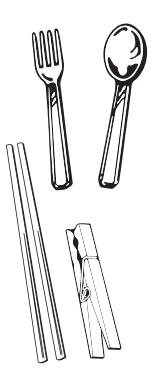
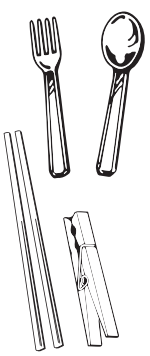
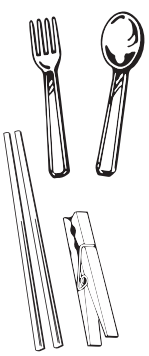
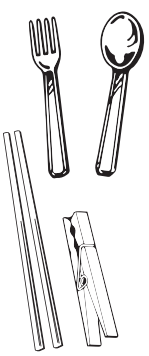
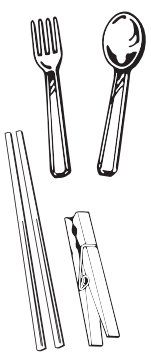
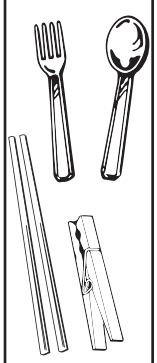
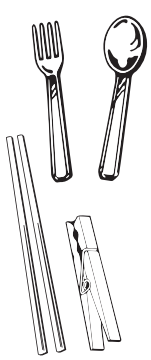
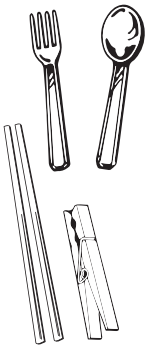
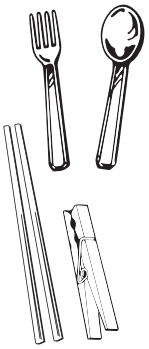
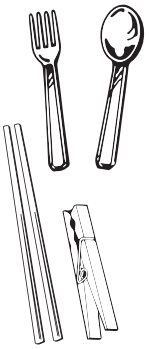
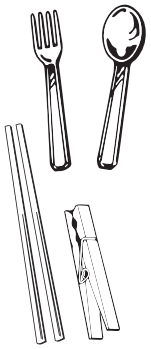
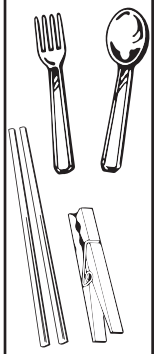
EVOLUTION BY NATURAL SELECTION: INSECT EVOLUTION TABLE

HABITAT COLOR: WHITE BLACK (CIRCLE ONE)

PLAYERS		INSECT 1	INSECT 2	INSECT 3	INSECT 4	INSECT 5	INSECT 6
ROUND 1	STARTING TYPES (CIRCLE ONE)						
	TOTAL CRITTERS EATEN						
ROUND 2	NEW TYPES (CIRCLE ONE)						
	TOTAL CRITTERS EATEN						
FINAL	ENDING TYPES (CIRCLE ONE)